

SPRING 2012

# COMING SOON:

**A WINDOW OF  
OPPORTUNITY FOR  
THE NEXT SPACE AGE**

**Building the Next Generation  
Space Launch Vehicle**

**The Official NSS Stance  
on Space Development**

**The Nine Lives of  
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# COUNTDOWN...03

## **Echo II, a Balloon Satellite**

Echo II is shown here undergoing a tensile stress test in a dirigible hanger at Weekesville, North Carolina. A dirigible is a type of aerostat or "lighter-than-air" aircraft. The 135-foot rigidized balloon satellite was sent into orbit as a passive communications experiment by NASA on January 25, 1964.



N.A.S.A.

IMAGE CREDIT: © NASA



# ...02

## **Expedition 30 Soyuz Rolls to the Pad**

The Soyuz TMA-03M spacecraft is rolled out by train on its way to the launch pad at the Baikonur Cosmodrome, Kazakhstan, Monday, December 19, 2011. The launch of the Soyuz spacecraft with Expedition 30 Soyuz Commander Oleg Kononenko of Russia, NASA Flight Engineer Don Pettit, and European Space Agency astronaut and Flight Engineer Andre Kuipers launched at 1:16 p.m. GMT on Wednesday, December 21.



IMAGE CREDIT: © NASA/CARLA CIOFFI

**Festival of Lights**

The green ring is made of tiny particles of warm dust whose composition is very similar to smog found here on Earth. The red cloud in the center is most likely made of dust that is more metallic and cooler than the surrounding regions. HD 278942, the bright star in the middle of the red cloud, is so luminous that it is the likely cause of the surrounding ring's glow. The bright greenish-yellow region left of center is similar to the ring, though more dense. The bluish-white stars scattered throughout are stars located both in front of, and behind, the nebula.

# ...LIFT OFF!

## Kepler Launch in 2009

On Launch Pad 17-B at Cape Canaveral Air Force Station in Florida, United Launch Alliance's Delta II rocket carrying NASA's Kepler spacecraft rose through the exhaust cloud created by the firing of the rocket's engines. Liftoff was on time at 10:49 p.m. EST on March 6, 2009.

The Kepler telescope is designed to search the nearby region of our galaxy for Earth-size planets orbiting in the habitable zone of stars like our Sun. The habitable zone is the region around a star where temperatures permit water to be liquid on a planet's surface. The challenge for Kepler is to look at a large number of stars and statistically estimate the total number of Earth-size planets orbiting Sun-like stars in the habitable zone. Kepler will survey more than 100,000 stars in our galaxy.

IMAGE CREDIT: © NASA/CARLA CIOFFI

**SPRING 2012**



Cover Image © NASA

#### A New Apollo Level Space Age

An artist rendition depicts past space accomplishments with Neil Armstrong and Buzz Aldrin's spacesuits from the 1969 Apollo 11 mission next to our future aspirations. In the foreground, NASA's Robonaut 2 points towards the proposed Ares V rocket, which will be able to lift more mass than any other launch vehicle in history. The futuristic spacecraft in the middle will be able to utilize oxygen produced on the Moon for propellant.

IMAGE CREDIT:  
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AIR AND SPACE MUSEUM  
IMAGE CREDIT: © NASA/  
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AND ASSOCIATES



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## GOODBYE FRIENDS, IT'S BEEN A GREAT MISSION.

By the time you read this, my tenure as the executive director of the National Space Society will have drawn to a close, and along with it yet another chapter in my continuing quest in what may best be described as “synergistic technological philanthropy.”

Synergistic, because opening the frontier of space for our civilization is not an individual or unilateral effort of some entity; it is an ongoing investment in cooperation across all levels of community, which ultimately must be embraced by our species.

Technological, based on the understanding that technology (by definition, applied science) must be driven by our ability to relate multiple forms and depths of knowledge in a coherent manner to draw out what matters—and, guided by what wisdom we can bring to bear to coalesce and assess the complex matters.

Philanthropy, because neither business nor life really is about short-term monetary return on investment—it is about our willingness to invest in the future, and what resources we dare to commit in order to secure the future we want to see come to pass.

For those who know me personally, it is abundantly clear that as far as space is concerned, I am “all in” on all three counts. Synergistic technological philanthropy is not about waiting for the future; it is about getting out there and making it! That is the business we have to engage in. That is the opportunity before us. Let's make it real.

Ad Astra!



Gary Barnhard  
Executive Director (ex-officio)  
National Space Society



## A BRIGHT FUTURE OF CHALLENGES TO CONQUER AND OF DREAMS TO ASPIRE.

I am honored to take over as the National Space Society's executive director as our organization enters its 25th year following the merger of the National Space Institute and the L5 Society in 1987. I'd like to express my thanks to our outgoing executive director Gary Barnhard for his many years of service to NSS. I also thank you, our members and chapters, for your ongoing support of the society as we pursue the vision of human settlements beyond the Earth and using the vast resources of space for the betterment of life here at home. It's your interest in—and commitment to—these goals that make our society THE preeminent space advocacy organization and citizen's voice on space.

These are challenging times for our country and for its future in space, but I view challenges as opportunities. I look forward to strengthening our membership, building new relationships, and creating new opportunities in and from space. I believe as an organization we have the ability to be a prominent voice in defining the policies and future programs which will culminate in the realization of human settlements in space and the harnessing of vast resources currently beyond our reach. We have many exciting things planned this year, including the release of an updated roadmap for space settlement, a Congressional campaign, and what we expect will be the best International Space Development Conference in years.

As we embark on our next 25 years, we ask for your continued support. We need you to be active in your local chapters, to engage the uninitiated on the excitement of space, and to support our fundraising campaigns. Together, we'll create our future in space!

I look forward to serving.

Ad Astra!



Paul E. Damphousse  
Executive Director  
National Space Society



## LETTER FROM THE PUBLISHER

### Ring of Fire

NGC 4151 is located about 43 million light years away from the Earth and is one of the nearest galaxies that contains an actively growing black hole. Because of this proximity, it offers one of the best chances of studying the interaction between an active supermassive black hole and the surrounding gas of its host galaxy.

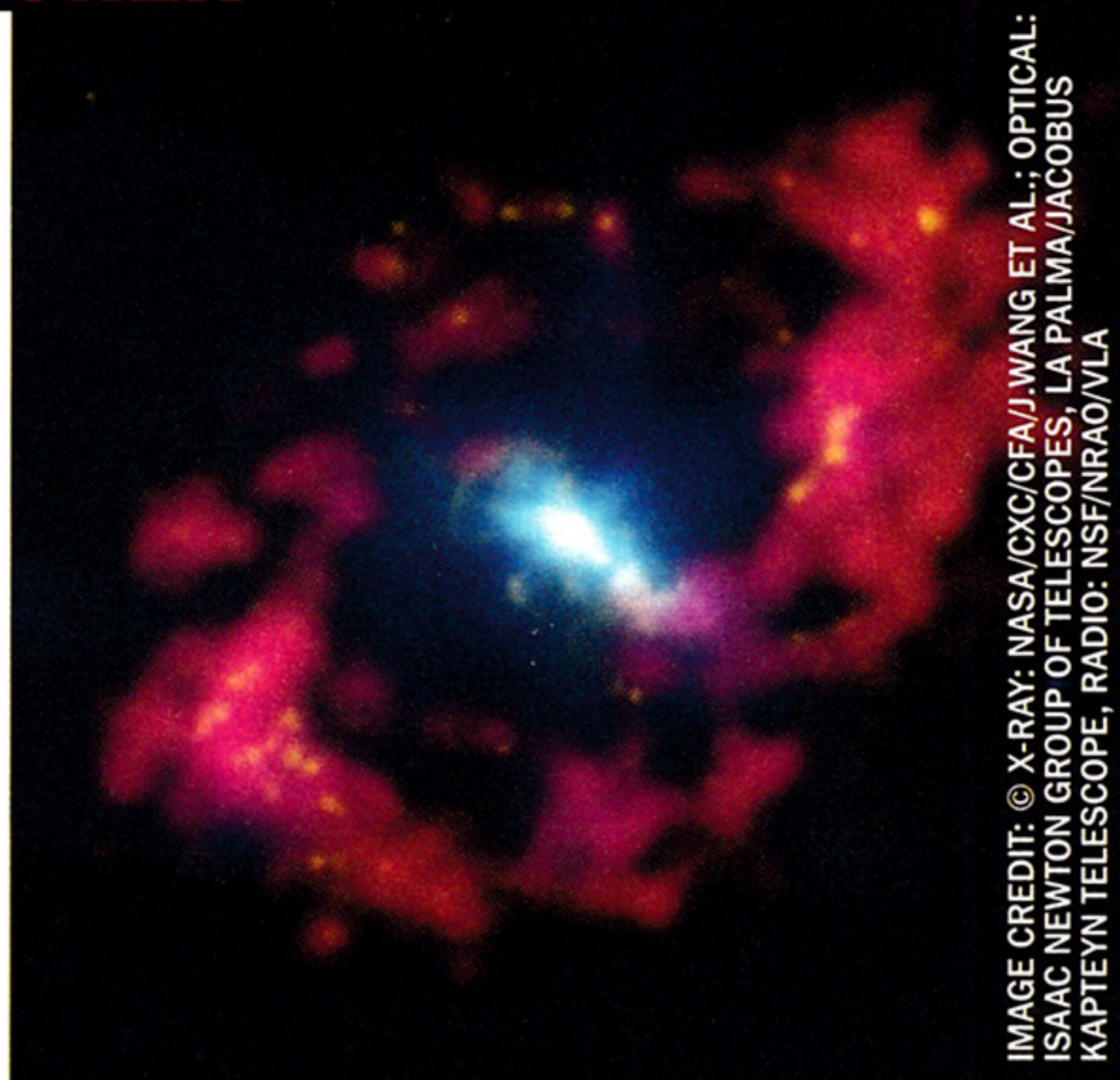


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Dear Ad Astra reader,

Are we on the verge of a new space age? Bruce Cordell thinks we are. Based on historical trends and the Maslow Window model, he sees that a resurgence of public interest in space exploration is coming soon! And that's great news for space enthusiasts like us. In this issue, we look at the many preparations needed to send mankind back to the Moon and beyond, and how they'll flourish there.

But when will we actually see these things happen? According to Cordell, a Maslow Window, or a period of high interest in space, is due by mid-decade. The last Maslow Window opened during Kennedy's presidency in the early 60s, the period when Wernher von Braun fathered the American space program.

In "The Nine Lives of Wernher von Braun," Clifford McMurray relates how von Braun escaped death nine times before sending the first American into space or landing humans on the Moon (pg 22).

The Multi-Purpose Crew Vehicle and next generation Space Launch System that will take us into outer space is detailed in Harry Dhillon's article about NASA's program to build the heavy-lift rocket. The men and women who will ensure our space future may be those vying to win RASC-AL, NASA's design contest for young engineers and scientists (Wagner pg 38).

This exciting issue of "Ad Astra" shows that there's much to do as we lay the groundwork and foundation for our future in space and prepare for the next space age. It's fascinating to see the very first steps towards what could eventually become humanity's settlement of space.

Ad Astra!

Pat Silver  
Managing Editor

## CREATING A LASTING LEGACY

If you look back 500 years, few events stand out as truly important: some great artwork, a few religious and political reforms, and certain battles. Topping the list, though, is a discovery every child can recite, an event that shaped the entire world as we know it today—the voyage of Christopher Columbus and the explorations of a new world.

We are embarking on a similar journey, one that again will reshape the course of humanity. You have an opportunity to help bring it about as part of the lasting legacy we are building at the National Space Society (NSS), together with the world space community. Your vision of a future for all humanity, spread beyond these bounds of Earth, can be realized as testament to your courage and ability to imagine the possible.

If this is a legacy you wish to share with us, please consider remembering the NSS in your will or through a planned gift. For more information on making a bequest or planned gift to NSS, please see our web page at [www.nss.org/giving/planned](http://www.nss.org/giving/planned). In addition, a National Space Society liaison is available to answer your questions. Please call Rick Zucker at 508-651-9936 or e-mail him at [planned-giving@nss.org](mailto:planned-giving@nss.org).

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# A TRIBUTE TO AMERICA'S TWO GENERATIONS OF SPACE WORKERS

Over the last 50 years, many good people associated with differing aspects of space work have contributed to the next stage of human development—the movement from a single planet-bound species to a space-faring society. Everyone involved with space has made a contribution. But people who have toiled for a living in jobs related to space projects have made a special contribution. They have plowed the road for future generations to more easily travel, and helped us take the baby steps necessary before the leaps that will open the frontier of space to human endeavor. Some have spent their entire professional lives in service to a space project, and to the incredible machines that have changed our planet and become cultural icons. Unbelievable feats of engineering and production have been accomplished. Astonishing missions of exploration, servicing, and construction have been completed. All of them deserve recognition. All of their contributions are important, because the implications are enormous and beyond our capability to fully grasp.

The workers who have toiled for a living (and some still do today) in a job associated with vehicles meant for human occupancy deserve special recognition. The successes of the recently concluded space shuttle and ISS (construction phase) programs were built on the passion and commitment of each person who worked on it. These programs can be thought of as involving the second generation of space workers. All the workers can be justly proud of their respective contributions. The same can be said of the historical Mercury, Gemini, Apollo, and Skylab programs, which can be thought of as involving the first generation of space workers. These were the big ones. But there were other smaller, uncompleted, and unmanned projects.

These workers contributed their little piece of expertise on a daily basis as part of dedicated design, operations, and program support teams. They were the de facto miracle workers, the unsung heroes of every project, the “just plain folks” who rolled up their sleeves and did what needed to be done. Whether oriented to vehicles, operators, or missions, they all worked to surmount the challenges inherent in human spaceflight. They have demonstrated that human beings can perform tasks that cannot be done by robotics alone. They gave their blood, sweat, and tears, a portion of their limited time on this world, and in some cases, even their lives, to the ultimate goal of leaving our home planet.

Most of the original first generation of space workers have retired now or have passed on. And a great many second generation workers have recently been laid off, transferred, or retired. With hardly an exception, they all worked tirelessly right up until the end. They were committed to the success of the program. There was no slacking off. There was no mass exodus a few months early. Most of these workers stuck it out and gave their best effort right up until the last day. Of course they worked for a paycheck. But during the work flow of every eight-hour day, their productivity was driven by more than just task descriptions, schedules, or supervisory oversight. It

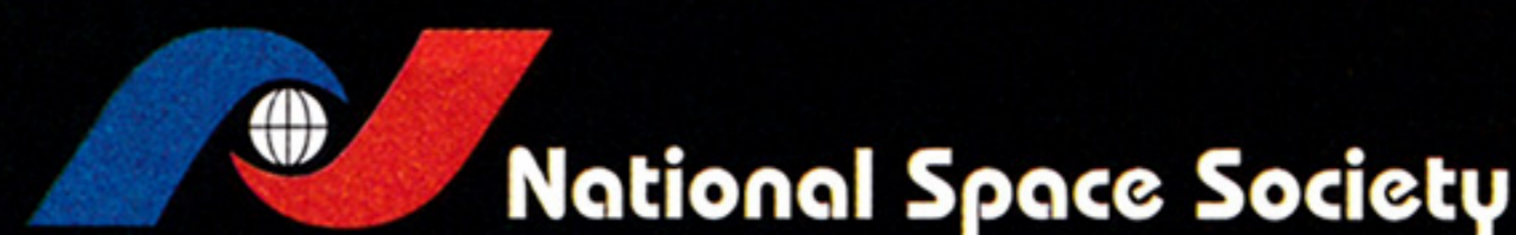


**Apollo 11 Commander Neil Armstrong speaks to Congress at a ceremony that honored fellow astronauts John Glenn, Buzz Aldrin, and Michael Collins. Each received a Congressional Gold Medal during the ceremony in the Capitol Rotunda on Nov. 16, 2011. The Gold Medal, Congress' highest expression of national appreciation for distinguished achievements and contributions, was first given to George Washington in 1776.**

was also driven by a powerful inner sense of worth—knowing they were doing something important and meaningful. These workers understood pride and honor; they believed it is in our human character to want to explore, discover, and experience. They knew the stakes were great—that there were overarching national and strategic overtones—and they reacted and produced accordingly.

Together with the astronauts, America's first two generations of space workers represented the driving force behind planet Earth's first venture into space. The third generation of space workers are here now—young, exuberant, self-assured, and industrious—just like those guys back in the 1960s. But many of these workers are now employed by small, entrepreneurial companies on commercial projects, rather than the big-name legacy companies on government-contracted projects. The economic climate has changed, the technology has matured, and the political landscape has transformed. But the force that drives our space workers and the values they believe in has remained the same.

President Bush emphasized our debt to the astronauts: “We find the best among us, send them forth into unmapped darkness, and pray they will return. They go in peace for all mankind, and all mankind is in their debt.” Yes, but we must not forget the vast army of workers who designed and built the equipment, performed the program tasks and operated the missions that eventually culminated in those human flights into space—flights that enabled a living being to “see and examine and touch ...” the new ocean firsthand. It was a team effort and our debt must be equitably distributed. To all those workers, we should humbly say thank you. We honor your hard work, your dedication, your sacrifice and your contributions in the service of humanity's travels to the heavens.



# AN UPDATE FOR NSS SPACE AMBASSADORS



Hello Space Ambassadors,

As many of you know, much progress has been made in the commercial space arena, as well as in deep space exploration research and goal setting. The search for other worlds like ours and the endeavor to discover other life forms in our universe is heating up on an unprecedented scale. We will all witness or be a part of some exciting accomplishments and discoveries over the next few years. Virgin Galactic is continuing to make great strides toward realized space tourism and commercial space applications. Successful flight testing of SpaceShipTwo and White Knight Two is continuing and completion of the world's first dedicated commercial spaceport, Spaceport America, is nearing completion.

Now back down to planet Earth. The Space Ambassador program will complete its first year at the beginning of the 2012 International Space Development Conference in Washington, D.C. The flight assignments are all still up for grabs and any one of you can accomplish that goal. Be sure to upload all of your presentation data on the Space Ambassadors website as this will be the data used to determine the top Space Ambassadors. If you haven't started yet, it's not too late for those of you with a strong will and the determination to make it to the top between now and ISDC 2012. Visit [www.spaceambassadors.com](http://www.spaceambassadors.com) and register today. It's time for all of you to make that strong effort and take your place among the stars.

It will be a very exciting day when we announce the top Space Ambassadors and issue their assignments. It's still hard to believe that one of you will be suiting up, strapping in, and hearing that countdown to launch into space above our tranquil atmosphere here on planet Earth. I can't wait to ask "how was it up there?" It will be your turn to pass that experience on to all of us on the ground and around the world. After all, isn't that what being a Space Ambassador is all about? Good luck to you all and see you up there!

Ad Astra,

Lee Jones  
Space Ambassador Program Director

## ABOUT THE SPACE AMBASSADOR PROGRAM

The mission of the Space Ambassador program is to communicate the benefits of space exploration to our daily lives and to inspire and educate young people and the public to pursue careers in science, engineering, and mathematics.

We wish to inspire a new generation of leaders to take an active role in helping to create the future.

Space Ambassadors will achieve this goal over the course of the program by scheduling and conducting speeches and presentations, particularly in schools and universities. The presentations may be constructed in any way you see fit. The passion you put into the presentation is the key ingredient necessary to be successful.

Each Space Ambassador will record the required data for each presentation given by logging into your secure personal account link on [SpaceAmbassadors.org](http://SpaceAmbassadors.org). The top professional Space Ambassadors will be selected at the end of the program.

The top professional Space Ambassador will be a space flight participant on Virgin Galactic's SpaceShipTwo.

The next-highest ranking Space Ambassadors will be assigned to Nastar Center, Zero-G, and Aurora Aerospace for space flight training.

A number of other ranked Space Ambassadors will be assigned to various events such as a barbecue at Spaceport America to witness the launch into space of the top ambassador. Other opportunities will be made available throughout the course of the program run through the addition of new associate sponsors.

For more information, visit [SpaceAmbassadors.org](http://SpaceAmbassadors.org).



## Astronaut Tests SAFER Backpack

Astronaut Mark Lee tests the new backpack called Simplified Aid for EVA Rescue (SAFER), a system designed for use in the event a crew member becomes untethered while conducting an EVA. The LITE payload employs lidar, which stands for light detection and ranging, a type of optical radar using laser pulses instead of radio waves to study Earth's atmosphere. Unprecedented views were obtained of cloud structures, storm systems, dust clouds, pollutants, forest burning, and surface reflectance. The STS-64 mission marked the first untethered U.S. EVA in 10 years, and was launched on September 9, 1994, aboard the Space Shuttle Orbiter Discovery.



# THE DEVELOPMENT OF SPACE:

## Opportunities to Improve Life on Earth

### A POSITION PAPER BY THE NATIONAL SPACE SOCIETY

Like its predecessor organizations the National Space Institute and the L5 Society, the National Space Society has long supported using space to improve life on Earth. Space activities have dramatically contributed to national and global well-being over the last 50 years, but NSS believes we have only begun to capture the opportunities offered by advancing space technology. At a time in which the nation and the world are seeking new industries that will lead the way into the future while creating rewarding jobs and delivering high value, NSS believes that the emerging opportunities to leverage and expand our space capabilities must not be overlooked.

For these reasons, the NSS Policy Committee has issued the following position paper that highlights this situation and calls on policymakers to:

1. provide visible leadership by publicly endorsing the importance of U.S. space activities to our future well-being;
2. identify and create the appropriate policies that will facilitate the development of new capabilities;
3. provide focused investment in key areas that will be linchpins of future U.S. leadership.

As a community of space advocates, we understand what many do not: Space activities provide tremendous value to our society and can be a source of great prosperity if properly developed. Working together, the government and the private sector are now poised to draw significant benefits from space for our country and for the world, if they act wisely. NSS will continue to promote this great opportunity.

It has long been a goal of United States space policy to use space to improve life on Earth. Senior officials have often held up our nation's space activities as an example of how wise investments and policies can bolster our economy, strengthen our government, and build for the future, as a key element in the use of technology to improve our society. In the last half-century, our space programs have unleashed a wave of innovation that has created new industries, promoted our security and economic prosperity, and stimulated commercial growth.

NSS strongly recommends the United States build on the lead it has created in the industrialization and use of space to improve life on Earth.

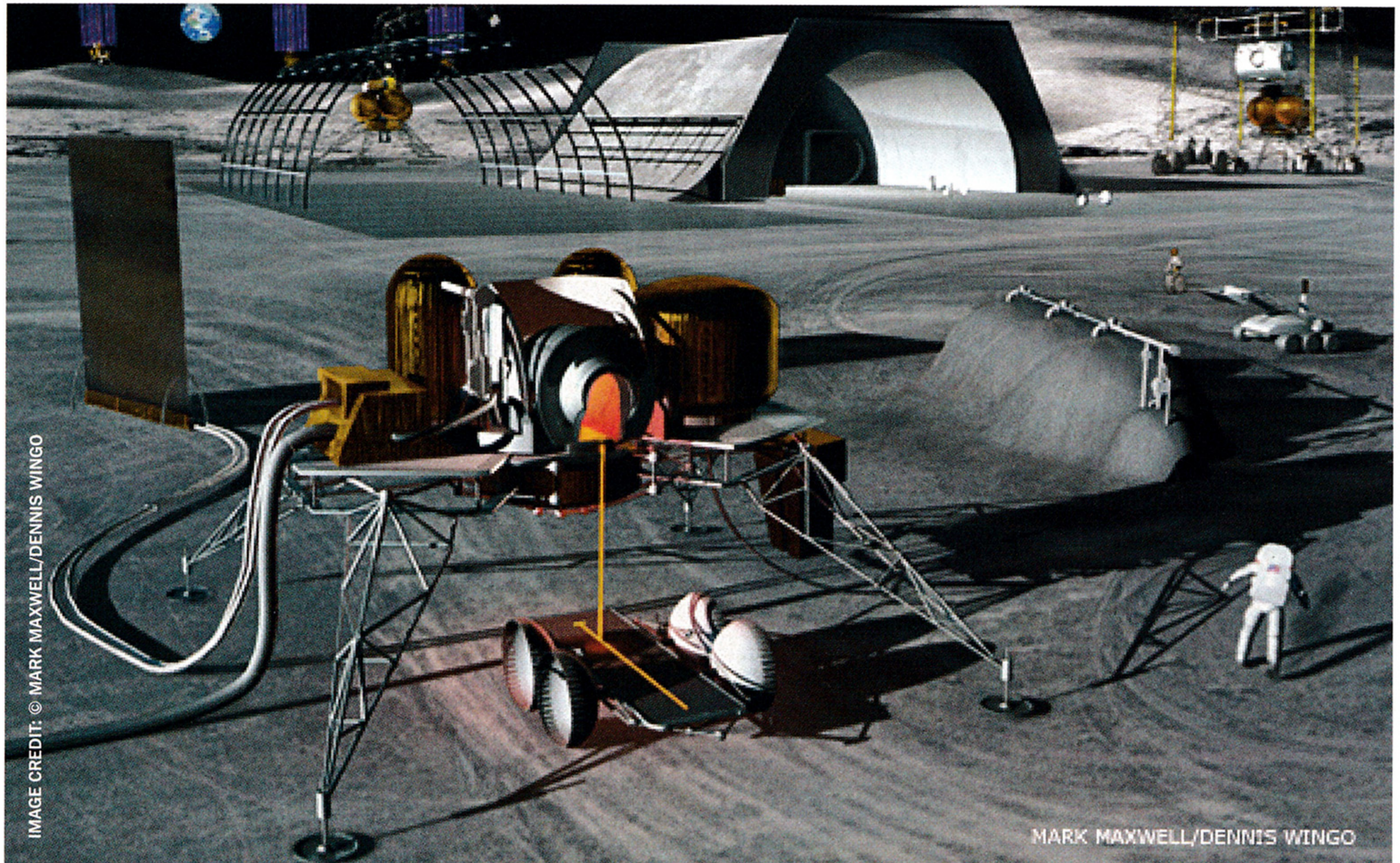
However, we as a nation should be concerned that the U.S. lead in space development is eroding and may possibly be lost, significantly impacting both the country's economy and our influence as a global leader. A few relatively straightforward steps in developing the resources of space would significantly help correct this situation in the competitive space environment of the 21st century.

### The Resources of Space

The Vision of NSS is "People living and working in thriving communities beyond the Earth, and the use of the vast resources of space for the dramatic betterment of humanity." These vast resources include solar energy, solar wind, and extraterrestrial materials including: metals, water, and other useful assets (e.g., He3) located on the Moon, the planets and their moons, and asteroids and comets. In addition, the unique characteristics of space create an environment that can be useful to humans by, for example, providing a vacuum with infinite volume, zero-gravity or very low gravity, and a line of sight to any point on the Earth's surface and atmosphere.

In the first 50 years of the Space Age, the United States has demonstrated the potential to use these vast resources of space for the dramatic betterment of humanity in a multitude of applications. Space-based services such as communications and weather monitoring, resource imaging and mapping, and uses of the global positioning system have





transformed the global economy in such fundamental ways that they are taken for granted today by most of their users. In the process, these services have created multi-hundred billion dollar industries that have stimulated economic development and enriched the lives of citizens in every nation on Earth.

The U.S. has been at the forefront of most of these innovations, and has reaped the rewards of its status as a leader. As spectacular as these advances have been, however, they are only the beginning of the substantial advances and benefits yet to come from “this new ocean.” Thanks to past investments in basic technology, system design, manufacturing processes, and operational techniques, there are many innovative uses of space systems now emerging that can support our economy and well-being. In the process, these new industries will produce new jobs and could underpin our economy well into the next century.

## What Space Development Really Means

To NSS, “space development” means any activity that makes practical use of the resources of space for the betterment of humankind. The president has cited the space program as a model for the big things we can achieve. Indeed, NSS believes that the biggest things in the space program have yet to be achieved.

Imagine, for example, broadband communication services delivered instantaneously and efficiently via American satellites to every corner of the globe. Imagine advanced sensors in space that will provide information about the Earth’s ocean, surface, and atmosphere that far exceeds what is available today. Imagine space radars that maintain

constant vigil on the borders of all nations. Or giant mirrors circling the Earth to safely redirect solar energy where needed for energy production, agriculture, or illumination, to influence the weather, or possibly to stimulate plants that help absorb carbon dioxide. Imagine ecologically friendly factories in orbit making use of the low gravity, vacuum, and solar energy there. Or lower-cost transportation into orbit for scientists and vacationers. This is just a small sample of the future capabilities and industries the U.S. may be able to create by harvesting the vast resources of space in the foreseeable future.

With appropriate leadership by the United States, our civilization may also witness these steps in the development of space:

- use of much higher-power, higher-capacity space communication platforms for numerous private and public applications;
- establishment of far more precise and reliable global positioning systems and timing references in space;
- use of all sections of the electromagnetic spectrum for active and passive remote sensing of natural and manmade phenomena for numerous public and private applications, including disaster prevention and mitigation, environmental and planetary protection from asteroid impact, and effective use of the Earth’s resources;
- extensive remote sensing of the Earth, its environment, and cislunar space from the wide aperture offered by the lunar surface;
- protection of the Earth from asteroid impact;
- low- or zero-gravity orbital facilities to create unique products and experiences;

- low- or zero-gravity orbital facilities to provide recreational opportunities and improve human health;
- eventual reliable, safe, and economical disposal of highly hazardous material away from the Earth's ecosphere;
- reflection of sunlight from satellites in Earth orbit to improve life on Earth;
- ability to carefully modify Earth's weather and climate from space;
- significant improvement of Earth's food supply from space by enhancements to farming and ranching;
- enhancement of Earth's fresh water availability by remote sensing and providing energy from space;
- ability to economically harvest solar energy in space to produce electricity on Earth; and
- mining of lunar, asteroidal, and planetary bodies for materials that improve life on Earth.

These emerging uses of space will be enabled by new and emerging service industries, such as:

- innovative space launch and in-space transportation capabilities;
- ground control and operation of orbiting facilities;
- scientific investigations into the nature and use of the space environment;
- servicing orbiting satellites for repair or replenishment of consumables;
- orbital construction and maintenance; and
- mitigation and removal of orbital debris that impede free use of Earth orbit.

The U.S. still has the leading capability to develop productive uses of space such as these. But other nations seem to understand these potential industries and their implications for future jobs and prosperity better than we do, and are moving to capture them. If national leadership does not focus on these opportunities, our country will lose the critical competitive edge we have now in this emerging sector of the global economy.

## Visible Leadership

NSS believes that the key to realization of these potential industries does not necessarily require significantly increased federal investment, although focused government technology development and demonstration programs will continue to be needed. Leadership can and should also take other forms. Just the mention of these potential futures by our nation's leaders can influence millions of young people to devote their energies and careers to this vision and attract the attention of astute investors in the private sector. Such moral leadership can help illuminate the future for many of our citizens who seek a positive course.

## Federal Policies for Space Development

Moreover, just as wise federal policies helped promote the widespread civil use of GPS and remote sensing satellites and gave us services like direct broadcast television, appropriate policies can nurture the space industries of tomorrow.

NASA can help promote new applications of space resources, and, to implement current national policies, NASA should be directed to work with other appropriate agencies, the private sector, academia, and the international communities to obtain, produce, and provide information

relating to all issues important for the development of space, including essential technologies. This would include identification of the material and energy resources of space and examination of the status of technologies necessary for their development and use, including space-based solar power for energy supply to Earth.

To help promote such developments, the government could offer to buy launch services at a significantly reduced price, thereby providing a market that could stimulate development of advanced launch systems conducive to accelerated space development. Or the government could establish a tax exemption on any products produced in or services provided from space by a U.S. corporation.

These examples of generalized policies to promote space development should be accompanied by specific policies to promote emerging space applications as they mature. As history has shown, appropriate removal of unnecessary legal and policy barriers can provide significant impetus to the development of new capabilities and industries.

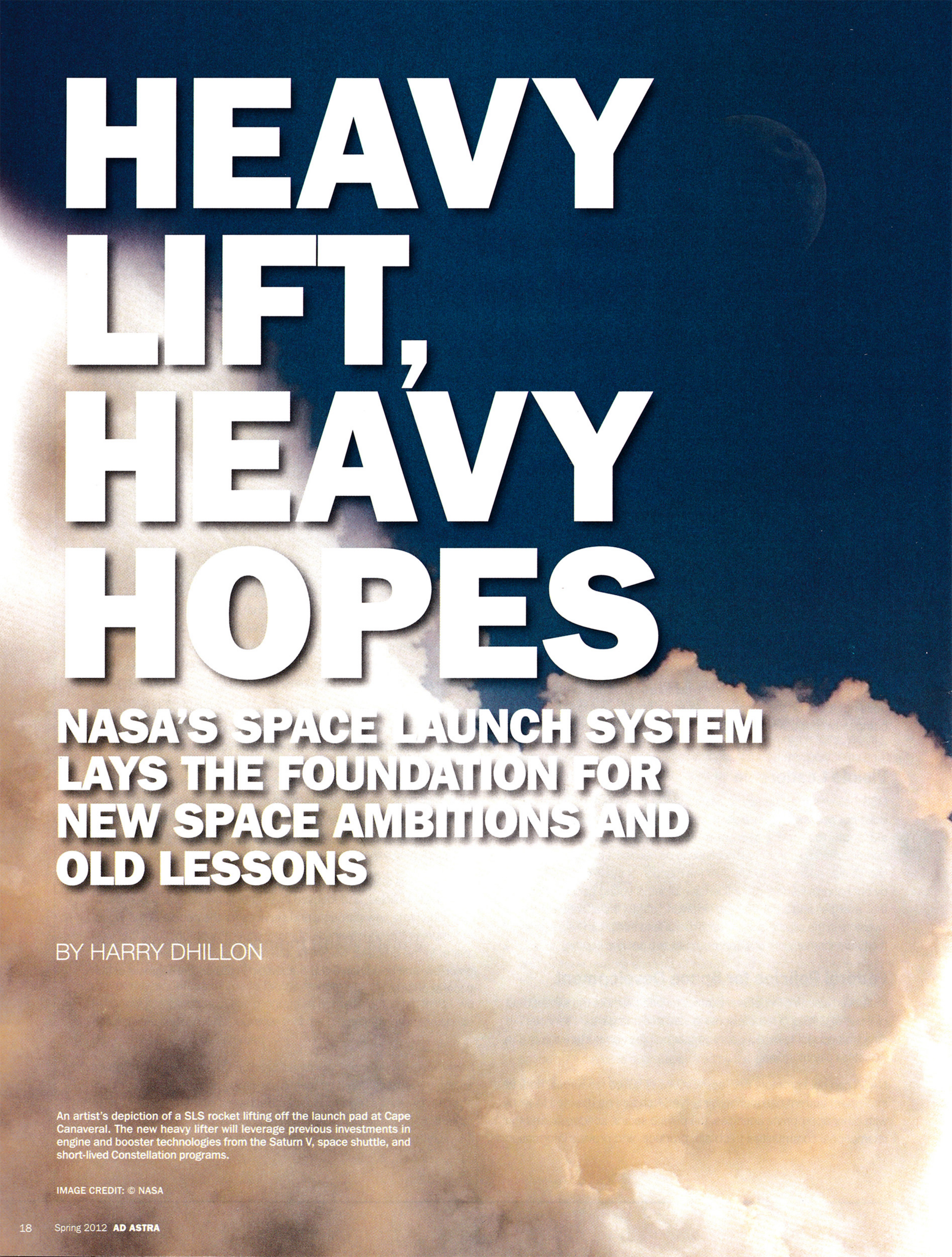
## Implications

Unfortunately, it seems that we simply are not sufficiently attending to these great opportunities. Some badly needed capabilities are not being developed. National leaders aren't calling attention to these potential industries. And scant attention is being paid to developing innovative policies that will promote the next generation of such revolutionary space applications.

The nation's response to Sputnik was not just Project Apollo and the human spaceflight program, but also the development of civil, commercial, and military uses of space that are now major contributors to our nation's and the world's safety and well-being. Nurtured by federal investments and sound policy decisions, we have developed space industries worth hundreds of billions of dollars each year that have provided significant value to the nation. But this is only the beginning.

We must recognize that our nation's role in the opening of the space frontier must not be limited by lack of foresight and imagination. We have only begun to emerge as a space-faring civilization. There is truly an entire universe out there for us to develop for the common good. The U.S. is the leader in the practical applications of space to meet the needs of Earth, but we will soon lose that role if we do not address the apparent lack of focus and policy innovation. We must as a nation come together, and embrace the great opportunity that waits in space for those who build on what prior generations gave us.

By taking these relatively simple and efficient steps (visible endorsement, appropriate policies, and focused investment), the federal government can help create new products and services for the people of the world and improve the effectiveness of many government functions that use space. In the process, we will create new industries, develop jobs of tomorrow, and help ensure U.S. leadership in this critical segment of the global economy.



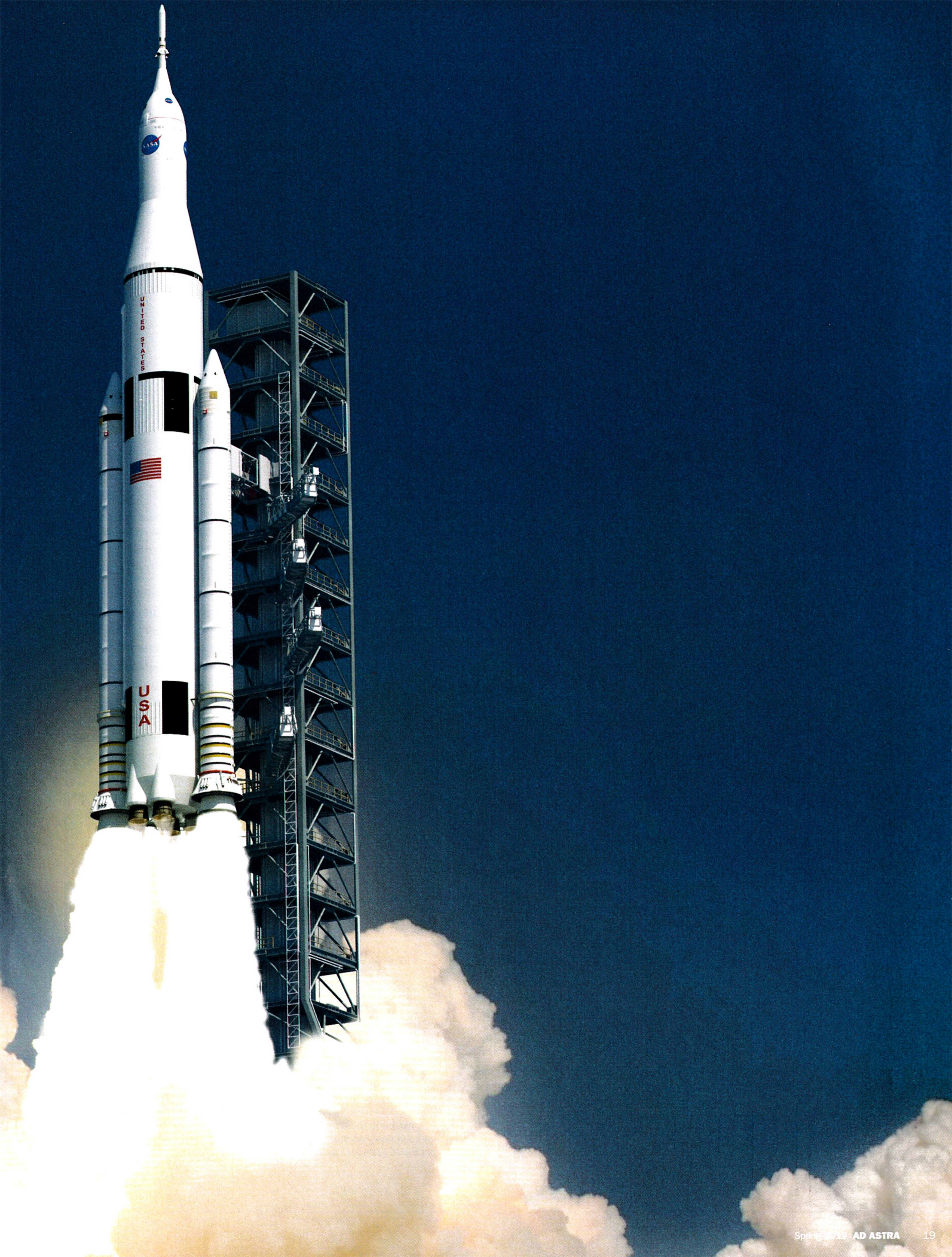
# HEAVY LIFT, HEAVY HOPES

**NASA'S SPACE LAUNCH SYSTEM  
LAYS THE FOUNDATION FOR  
NEW SPACE AMBITIONS AND  
OLD LESSONS**

BY HARRY DHILLON

An artist's depiction of a SLS rocket lifting off the launch pad at Cape Canaveral. The new heavy lifter will leverage previous investments in engine and booster technologies from the Saturn V, space shuttle, and short-lived Constellation programs.

IMAGE CREDIT: © NASA





**NASA Administrator James E. Webb knew the importance of maintaining an intimate and trusting relationship with the legislative branch of government and practiced that philosophy well.**

For many who have followed U.S. space policy over the past decade, the future has been a long time coming. In February 2010, the Obama administration proposed cancelling the Constellation program, consisting of the Orion manned vehicle, Altair lunar lander, and Ares launch vehicle family, after more than \$9 billion had already been spent. After considerable pushback from Congress, industry leaders, and the public, the administration was forced to tacitly acknowledge its haste and reintegrated Orion into its new space policy. The policy was refocused towards seeding a commercial capability to resupply the International Space Station and investing in deep-space exploration systems.

Adding to that, in July 2011, the final flight of Atlantis marked the formal end of the space shuttle program and the beginning of a partial downsizing of an aerospace industrial base that could erode away without further detailed plans from NASA. As part of last year's NASA authorization bill, the agency was ordered by Congress to lay out a plan and funding requirement for a next-generation heavy-lift launcher, designed to carry the ex-Orion spacecraft, since redubbed the Multi-Purpose Crew Vehicle (MPCV), and future assets into Earth orbit and deeper space. Congress had hoped to receive a plan as early as January of last year, but squabbles within NASA and the administration over leaks of price estimates of various design choices—all in the midst of public battles over the broader federal budget—caused further delays.

However, the day Congress had been waiting for came last September, when the next-generation Space Launch System (SLS) was formally announced. The initial cost of the program over the next six years is \$18 billion, with \$10 billion earmarked for SLS and the rest for the MPCV and upgraded launch infrastructure. The first flight of the SLS is envisioned by the end of 2017. So far, appropriators in Congress have indicated that the implied \$3 billion a year is within the current funding levels beginning in 2012. While the Saturn V vehicles that powered Apollo to the Moon in the 1960s and 1970s had a lift capacity of 130 tons, the initial SLS configuration will have a lift capacity of 70 tons, evolving to 130-150 tons over time.

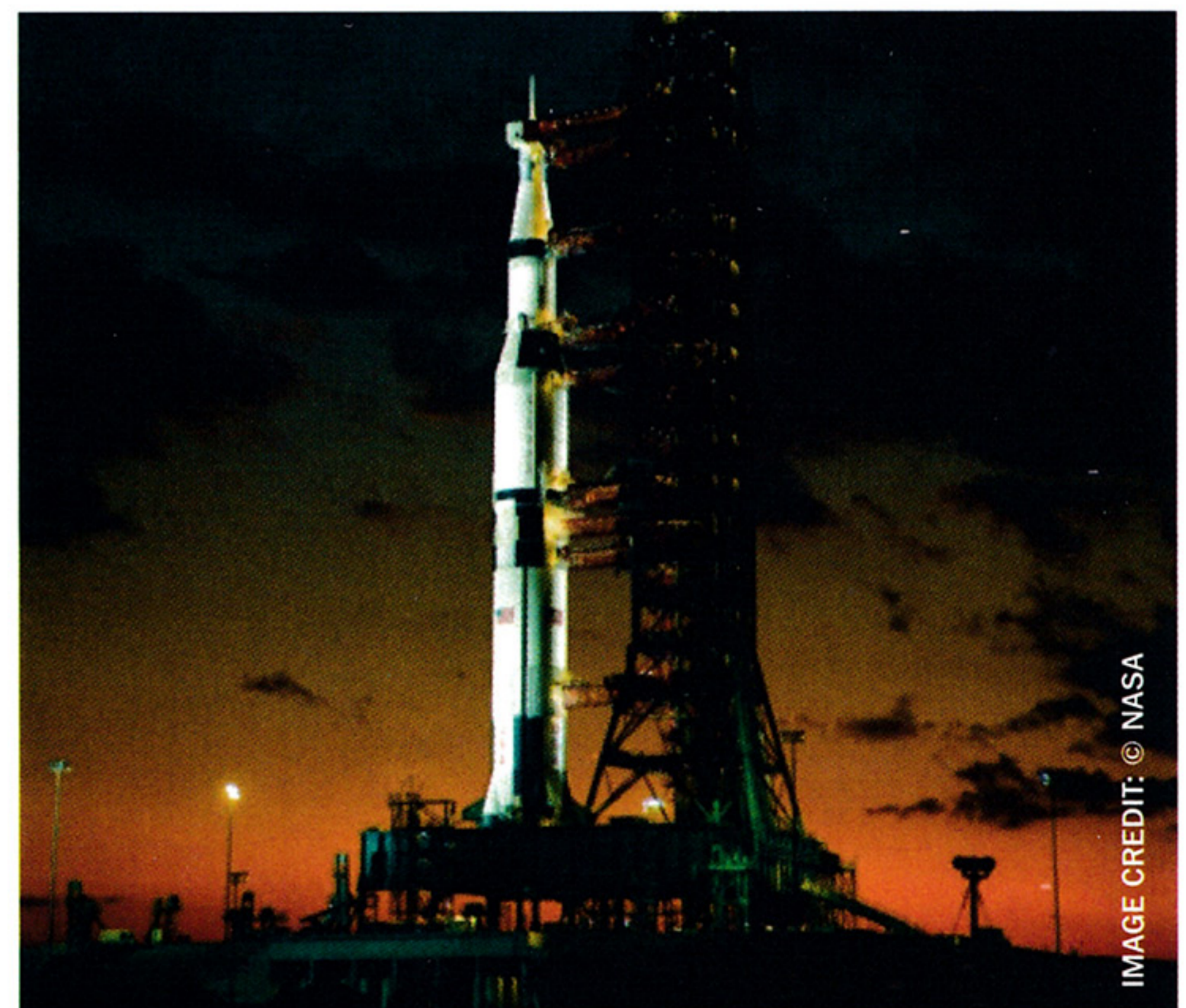
As part of an effort to build on past investments and to control costs, NASA has specified that the core stage will be powered by three to five space shuttle main engines, with an upper-stage based on the

J-2X engines used in the Saturn V (though an early version may use a Delta IV upper stage). Strap-on boosters will provide the added kick. They will initially be based on shuttle-derived solid rocket boosters developed by ATK for the Ares I vehicle; however, NASA is already planning to open a wider competition for more powerful strap-on boosters, potentially considering liquid versions as well.

NASA currently envisions the first orbital flight of an unmanned MPCV to occur in 2014, using a launch vehicle that has yet to be finalized (though a Delta IV Heavy rocket has been considered). The MPCV could then support manned resupply missions to the International Space Station if similarly capable commercial systems did not materialize. The initial flight of the SLS would occur in 2017 and propel an unmanned MPCV around the Moon to validate the capsule's re-entry system from deeper space; that would be followed by a manned lunar fly-by mission in 2021.

As NASA provides a program infrastructure for SLS, it should take stock of some lessons. First, it's in NASA's best interest to maintain a close relationship with the legislative branch of the U.S. government, and not just serve as a front-end to the executive branch. Even if the relationship gets testy at times, keeping one's purse close can be helpful. Despite assured funding in the near-term, it's entirely conceivable that the austere budget environment that will dominate the scene in Washington will keep pressure on costs and future outlays. Also, members of Congress will be keen to protect constituencies and facilities that can benefit from an expanded industrial base supporting SLS.

Finally, as in all complex engineering programs, unforeseen challenges may test the agency and its contractors to deliver a capability on schedule and within budget. James Webb, the administrator who guided NASA in the 1960s, knew that intimately well and worked behind the scenes to maintain a close, trusting relationship with Congress, even during the midst of the Apollo 1 disaster. Contrast that with the run-up to the SLS announcement, when NASA was criticized for not informing Congress soon enough after deciding to go along with the administration's plan to cancel



**In retrospect, the decision to cancel the Saturn V program in the mid-1970s was a watershed moment in national space policy, as it would later lay bare extended gaps in U.S. manned spaceflight.**

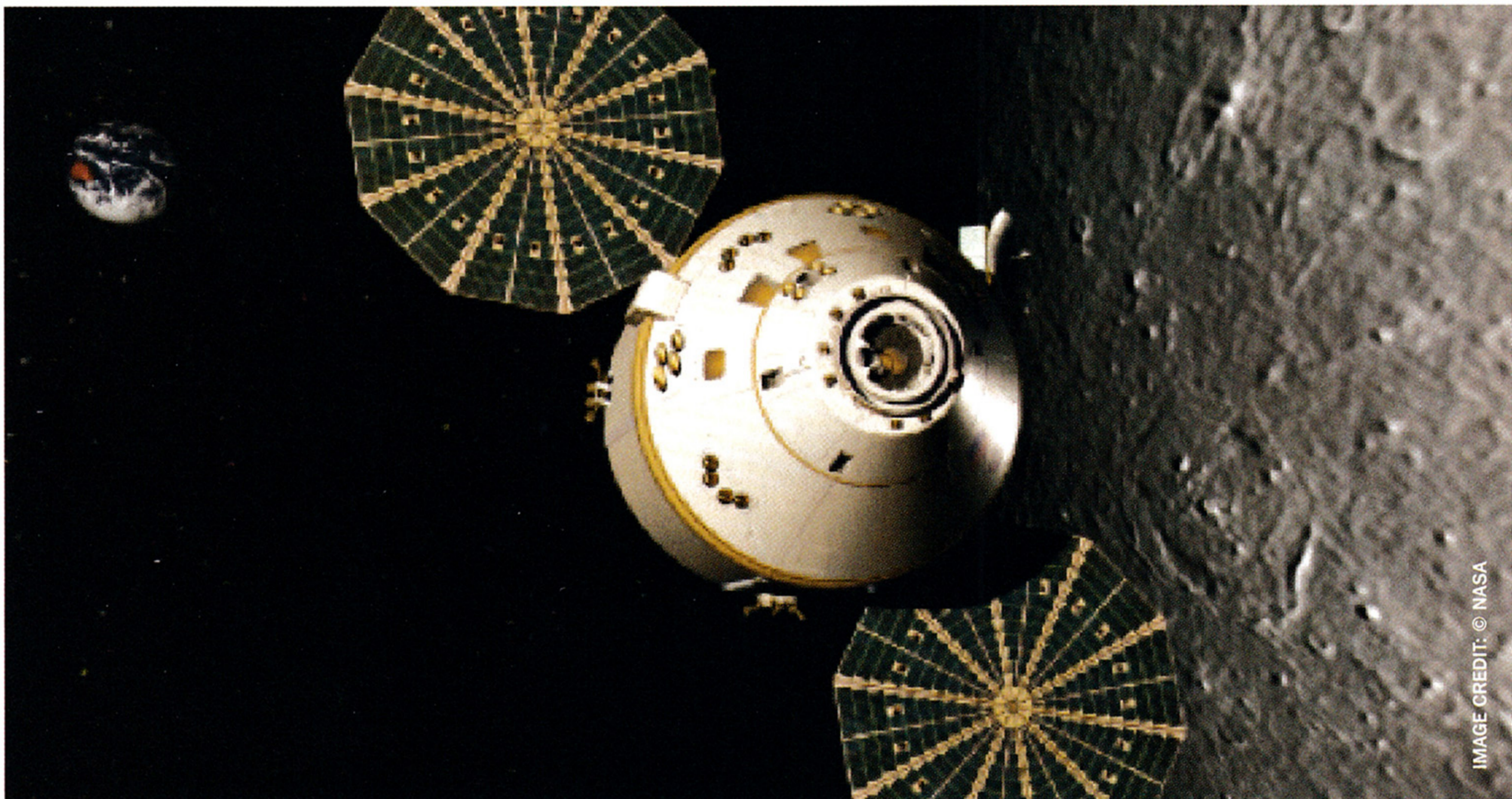


IMAGE CREDIT: © NASA

The former Orion manned space vehicle has found a new life as the Multi-Purpose Crew Vehicle (MPCV) and will form one of the first payloads for the SLS.

the Constellation program. Then, the administration was accused of leaking preliminary cost figures for SLS that reached nearly \$63 billion through 2025. The latter incident prompted Senators Kay Bailey Hutchinson (R-Texas) and Bill Nelson (D-Florida) to charge the administration with “undermining” America’s space program. A Congressional investigation was launched to look into delays in the decision-making process within NASA, even issuing subpoenas for internal documents. Since the SLS announcement, that investigation was re-reviewed by the Senate. NASA cannot afford to be caught in the middle between Congress and the administration.

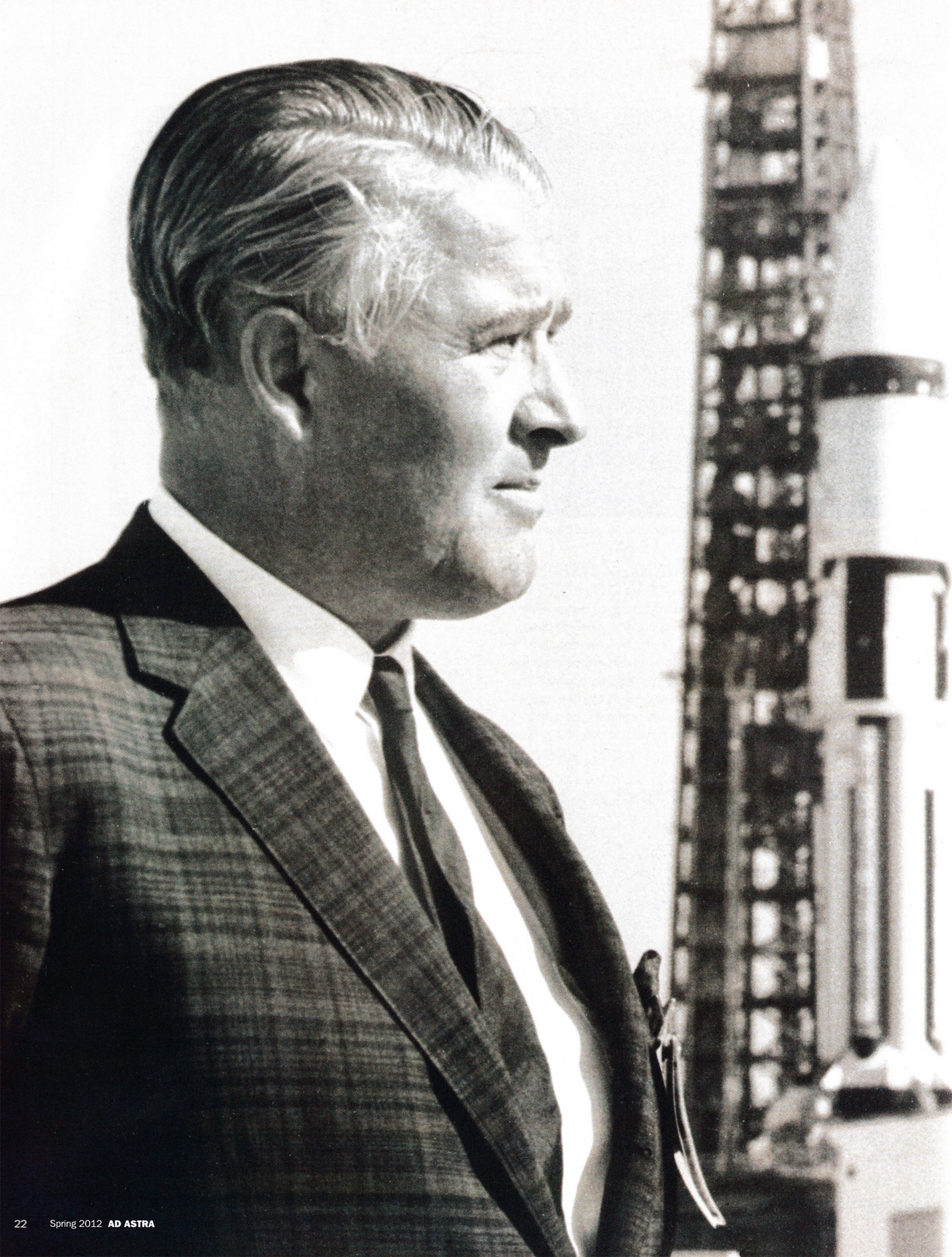
Secondly, and perhaps more importantly, NASA needs to learn the lessons of Apollo, not just continually commemorate its achievement. The decision to retire the Saturn V can now be viewed as a watershed moment in national space policy, a decision that caused immense reverberations into the future. When the program was terminated in the mid-1970s, it presaged a lull in U.S. manned spaceflight that wasn’t closed until 1981. Now, with the end of the shuttle program, the country will again lose a manned capability—possibly through the end of the decade. NASA abandoned one of its greatest technological assets, after a history of proven performance, before the test program for its successor, the space shuttle, had even begun. As affirmed by reports from numerous space panels—from the Synthesis Group in 1991 to the Review of U.S. Human Space Flight Plans Committee in 2009—a heavy-lift capability is a national requirement, one that should not be prone to constant reinvention. It not only supports a broad industrial base, it supports national security by efficiently and economically addressing multiple national and military needs in space. Many observers have since noted that the MPCV-SLS configuration is markedly similar to the Apollo-Saturn V configuration that sent astronauts to the Moon; that is a validation of the judicious design choices and trade-offs that went into SLS’s predecessor. While the Nixon administration

is equally—if not more-so—to blame for the original policy failure, NASA should now become a champion for launch vehicle technology and structure a SLS program that can enjoy a long and secure production run, less susceptible to a premature budget axe.

To its credit, NASA has improved in one respect over the years, and that is in providing an open forum for communicating its activities. Its website provides a great example of open government, providing the rationale and supporting information for the American public on the agency’s efforts across multiple programs, not just in manned spaceflight. The challenge, in the context of the SLS, will now become not just managing a new development program, but engaging Congress and the American public in a broader dialogue over what new destinations and timetables will drive its long-range exploration initiatives through the first half of the 21st century. While the administration has proposed manned missions to an asteroid by 2025 and Mars by the mid-2030s, NASA should consider a phased capability that proves the potential of the MPCV and uses the Moon as a test bed for missions further into deep space. Destinations cannot be an end to themselves, and a lack of sustainable goals will only cripple the projects meant to reach them. As the long and costly road of a replacement heavy-lift capability has itself shown, those who forget the past are doomed to repeat it. In this age of intensified competitive challenges from many nations around the world, the stakes are too high. It’s time for NASA, and the country, to learn from the past and move forward towards a brighter future in space.

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*Harry Dhillon is a business executive with extensive experience in science and technology; he currently works at Inmarsat in Washington, D.C. He wrote about nuclear propulsion in space in the November/December 2002 issue of “Ad Astra.”*



# THE NINE LIVES OF WERNHER VON BRAUN

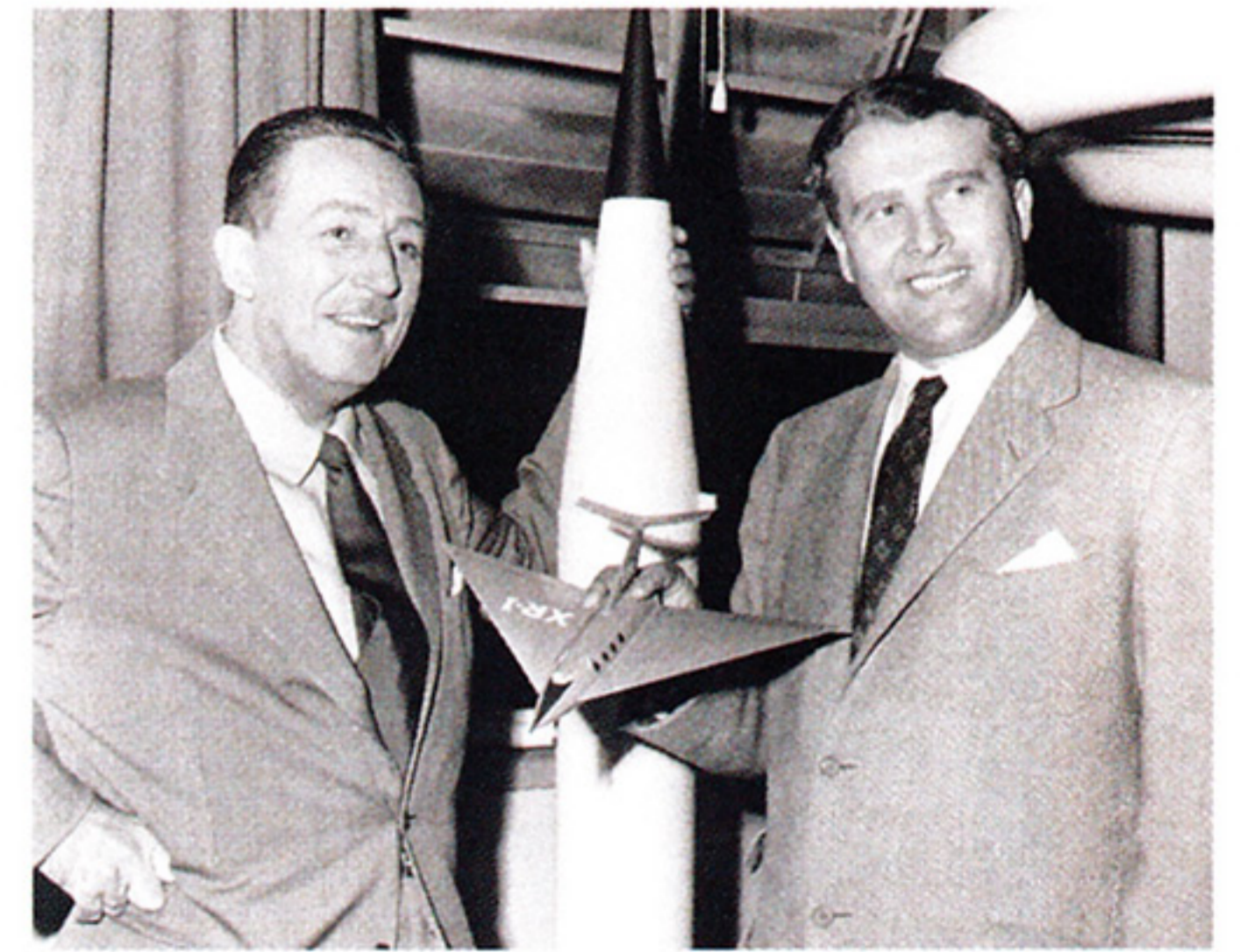
BY CLIFFORD R. MCMURRAY



Apollo 11 mission officials relax in the Launch Control Center following the successful Apollo 11 liftoff on July 16, 1969. IMAGE CREDIT: © NASA



Dr. Wernher von Braun explains the Saturn Launch System to President John F. Kennedy. IMAGE CREDIT: © NASA



Walt Disney and von Braun, seen in 1954 holding a model of his passenger ship, collaborated on a series of three educational films. IMAGE CREDIT: © NASA

Dr. Wernher von Braun stands in front of a Saturn IB launch vehicle at Kennedy Space Flight Center. Dr. von Braun led a team of German rocket scientists, called the Rocket Team, to the United States, first to Fort Bliss/White Sands, later being transferred to the Army Ballistic Missile Agency at Redstone Arsenal in Huntsville, Alabama. They were further transferred to the newly established NASA/Marshall Space Flight Center (MSFC) in Huntsville, Alabama in 1960, and Dr. von Braun became the center's first director. Under von Braun's direction, MSFC developed the Mercury-Redstone, which put the first American in space; and later the Saturn rockets, Saturn I, Saturn IB, and Saturn V. The Saturn V launch vehicle put the first human on the surface of the Moon, and a modified Saturn V vehicle placed Skylab, the first United States' experimental space station, into Earth orbit. Dr. von Braun was MSFC director from July 1960 to February 1970.

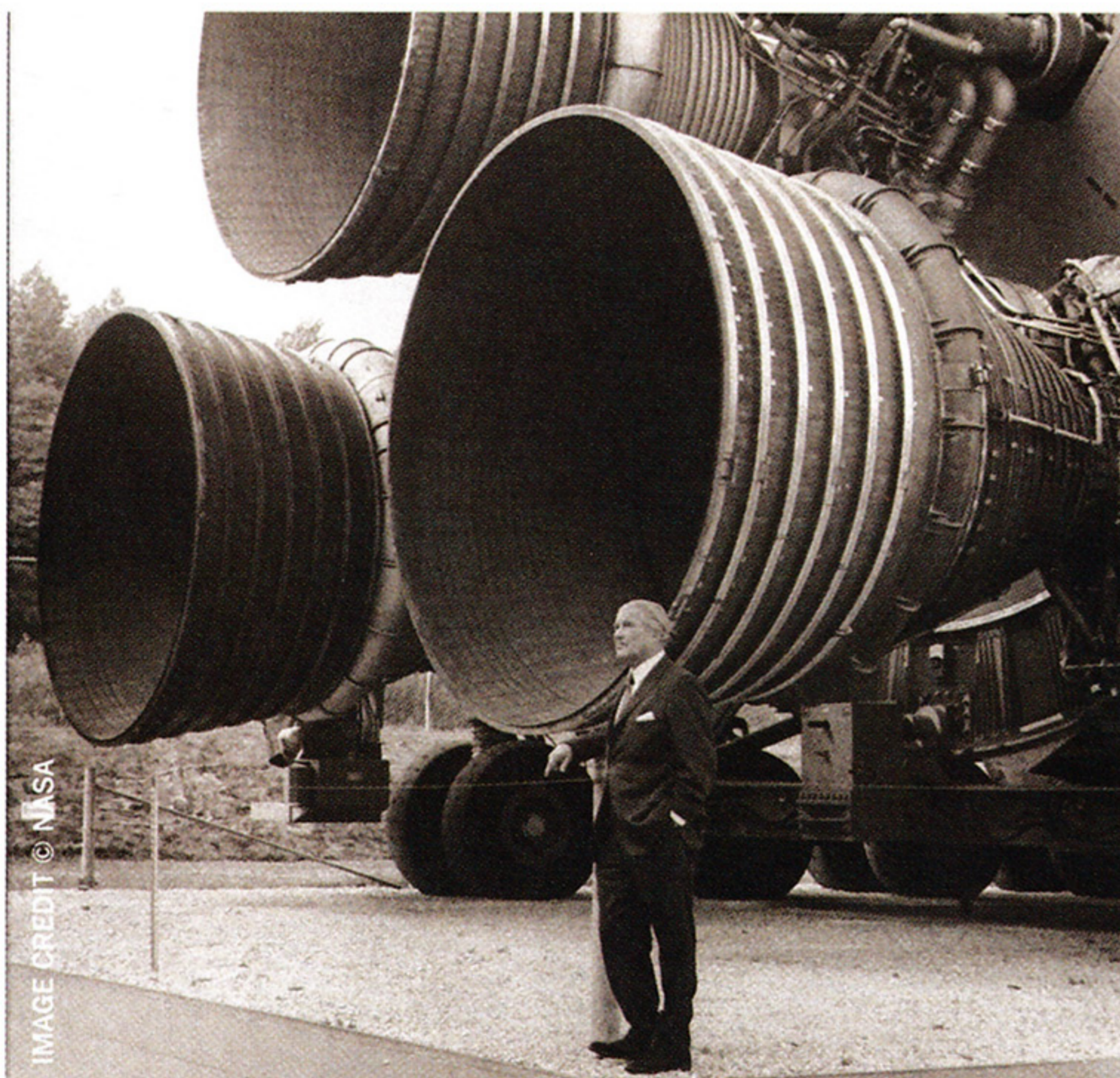
IMAGE CREDIT: © NASA

This year marks the centennial of the birth of the father of the American space program, arguably the single most important person in the history of spaceflight. Wernher von Braun was the chief engineer in the development of the V-2, the first ballistic missile (also the first rocket to fly outside the Earth's atmosphere and into space); the Redstone missile that launched the first American into space; and the Saturn V booster that sent the first humans to the Moon. In addition to these accomplishments, he was a tireless spokesman for the space movement. It is therefore one of history's more interesting "what if" questions to consider what the world would have been like without him. The record shows that there were plenty of chances for him to have died without accomplishing much of anything.

Born on March 23, 1912, von Braun entered the world at just the right time to be caught up in the dreams of spaceflight being popularized by Goddard, Tsiolkovsky, and Oberth. He joined the Verein für Raumschiffahrt (Society for Space Travel) in Berlin when he was a teenager. A rocket exhaust is a controlled explosion, and in those earliest tests by amateur enthusiasts with primitive test stands and equipment, the explosions often weren't very well controlled. Fellow VfR member Max Valier was killed when the rocket motor he was testing blew up. Von Braun wasn't present for this test, but he could have been.

The VfR members had enthusiasm, but little cash. The German Army, however, took an interest in their experiments as a possible path to very-long-range artillery. The amateurs fell by the wayside, and von Braun and the serious experimenters went to work for the Army in 1932—just before Hitler ascended to power. He got his PhD in physics at the expense of his employers, and assembled a team at Peenemünde to work on what would become the V-2.

Von Braun's first wartime brush with death came at the hands of the Royal Air Force on the night of August 17, 1943. Nearly 600 RAF bombers rained 1,800 tons of bombs onto the Peenemünde research station. The



Wernher von Braun stands in front of Saturn S1-B booster rocket motors.

raid was aimed at the living quarters of von Braun and his engineers, with the primary objective of killing as many of the staff as possible. The engineering and fabrication buildings, and the rocket test stands, were

a secondary target. They could be rebuilt, but British intelligence knew that the knowledge and experience of the von Braun team would be irreplaceable. Von Braun rode out the attack in an air raid shelter, but his chief propulsion engineer, Walter Thiel, was killed along with his entire family when their air raid shelter took a direct hit. Thiel was the only key member of von Braun's team to die that night, but three-fourths of the base housing was destroyed, and 732 others were killed. Von Braun emerged from his air raid shelter to find his office building in flames. He made several trips inside the burning building, some of whose walls had already collapsed, to salvage important engineering and test documents.

Von Braun's next near-death experience came at his own hands, as the result of an almost disastrous error in judgment. In early 1944, V-2 development had progressed to where missiles were being test-fired regularly, but many were disintegrating in the last moments of flight. The science of telemetry was in its infancy, and the engineers weren't getting enough data to determine the cause of the problem. In desperation, they tried visual observation, which required a field trip to the test target site in Poland. Von Braun knew that the missiles still weren't very accurate (they typically landed at least a mile or two from their target), so he and his army boss, General Walter Dornberger, set up their observation post directly on the bulls-eye, reasoning that this would be the safest place to be.

Not on this day.

As Dornberger describes the event, "I was standing in an open field, and . . . beheld the rocket coming out of the blue sky. I threw myself down . . . but a moment later a terrific explosion hurled me high into the air. I landed in a ditch and noted with some amazement that I . . . had not suffered as much as a scratch." Neither had von Braun, but the rocket had impacted only about 100 yards away.

If the dangers of missile testing and air attacks weren't enough, von Braun found himself a pawn in the dangerous political intrigues of the head of the SS, Heinrich Himmler. Grasping at ever more power, Himmler invited von Braun to transfer his V-2 project from the Army to the SS. Prudently, von Braun declined. A few weeks later, he found himself under arrest and accused of treason. He spent his 32nd birthday in detention, wondering about his fate. The file prepared by the secret police alleged that he'd been overheard saying that "his main task was to build a spaceship," and, with other engineers, he "made comments about the war turning out badly." Defeatism could be a capital offense in Nazi Germany, and with the V-2 suffering all the problems of an immature technology, von Braun was vulnerable to charges of insufficient zeal in executing his duties. He might have faced a firing squad, if not for the vigorous intervention of General Dornberger. Dornberger secured the "provisional" release of his invaluable chief engineer, and nothing further came of the charges—but the threat of the SS didn't end until the war was over.

The first V-2 was fired against London just weeks after D-Day. But it was a weapon ahead of its time, and made no difference in the outcome of the war. All the 3,200 V-2s fired in combat inflicted less damage on allied targets than a single bombing raid on Germany by the American bomber force.

By February 1945, the Peenemünde staff could hear the Russian artillery rumbling in the distance, and von Braun made plans to evacuate the base. The local mayor had some thoughts about drafting the rocket engineers into the infantry to fight in the defense of the area, in which case they would undoubtedly have been killed or captured, but von



Dr. Wernher von Braun and astronaut L. Gordon Cooper in the blockhouse during the recovery operation of MR-3 (Freedom 7) mission on May 5, 1961. The MR-3 mission, a 15-1/2 minutes sub-orbital test flight, put the first American, astronaut Alan Shepard, in space.

Braun had orders from higher up, and headed south to prepare the way for his team. The Third Reich was collapsing around him. Allied planes ruled the skies by daylight, and traffic moved only at night to avoid air attack. After a couple of days with little rest, his driver fell asleep at the wheel while they were traveling at about 60 mph. Von Braun later recalled, "The car ran to the right down the 12-meter high embankment, or rather it flew through the air, and landed after about a 40-meter flight...I was sleeping and awoke only during the flight because the tire noise suddenly stopped." Both von Braun and the driver were knocked unconscious in the crash that followed, and both men might have bled to death if help hadn't arrived quickly. Von Braun's shoulder was smashed and his left arm was broken in two places. He was patched up and sent on his way in a cast, but he was lucky to have survived.

A few weeks later he had to visit a hospital to have his arm reset (without benefit of anesthesia, which was in short supply). The orthopedic surgeon put him in traction with orders not to move. Just then, a flight of fighter-bombers attacked the town. While several bombs fell nearby and some patients were rushed to the relative safety of the basement, von Braun laid in his bed, trying not to move.

Even after he surrendered to the American Army, his troubles weren't over. On his very first night as a prisoner of war, a drunken Polish refugee who had been working as a cook for the Americans entered the barracks and headed up to von Braun's room with a pistol "to kill those German swine." An American soldier disarmed the man before he got to the top of the stairs.

A few weeks later, word reached von Braun from the Soviet occupation zone that the Russians had put a price on his head. They were as interested as the Americans in obtaining the services of the German

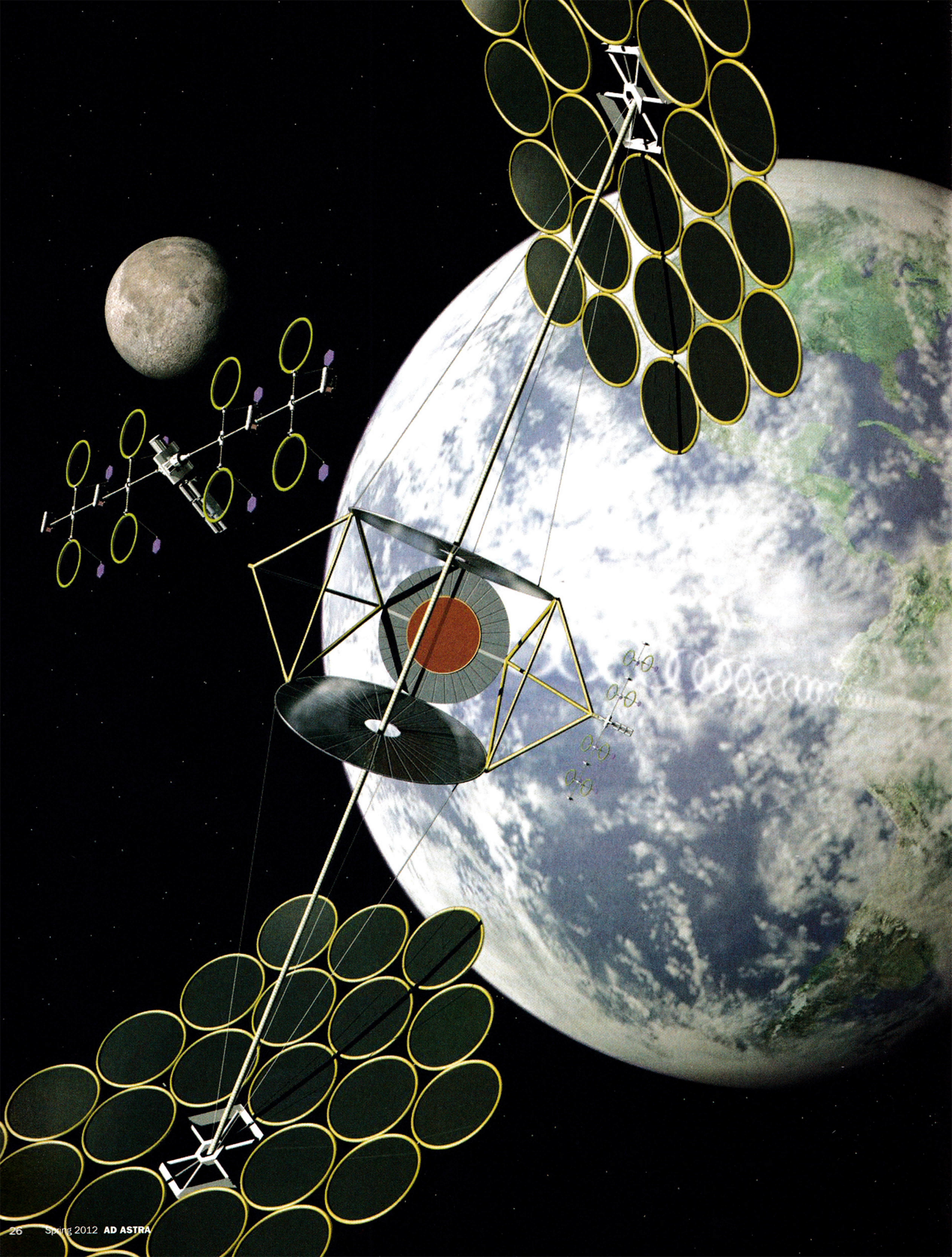
rocket team. Von Braun and his colleagues could not travel anywhere alone. A few days later, several men in American uniforms showed up in the village where von Braun was being held and struck up a conversation with them, suggesting they have a few drinks together. But the Germans were suspicious of the strangely accented English the men spoke, and so the would-be Russian kidnappers left empty-handed.

And so, after so many opportunities to disappear from history, von Braun found himself on a plane to America with 126 of his fellow German rocket engineers. In his newly adopted country, he would eventually get to build the rockets he had wanted to build all along—rockets that would be used not as weapons, but as instruments of exploration and the expansion of humanity into space. Von Braun was a gifted engineer and a brilliant technical manager, but he was more than that. He was a prophet of the coming Space Age. First in a series of articles in "Collier's" magazine, then in books such as "Conquest of the Moon" and "The Exploration of Mars," then as technical advisor to a series of episodes on Walt Disney's television show; and finally as author of a long-running monthly series of articles in "Popular Science" magazine, he introduced the American public to the concept of spaceflight as a serious, immediate possibility outside the realm of science fiction.

Only eight years after the crowning achievement of landing men on the Moon, and just shortly after founding the National Space Institute (which would eventually merge with the L-5 Society to form the National Space Society), von Braun lost his last contest with death. He died of cancer on June 16, 1977.

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*Clifford R. McMurray is a former executive vice president of the National Space Society.*





# ARE THINGS LOOKING UP FOR SPACE-BASED SOLAR POWER?

BY PETER GARRETSON

Solar power satellite sandwich or abascus concept.

IMAGE CREDIT: © NASA

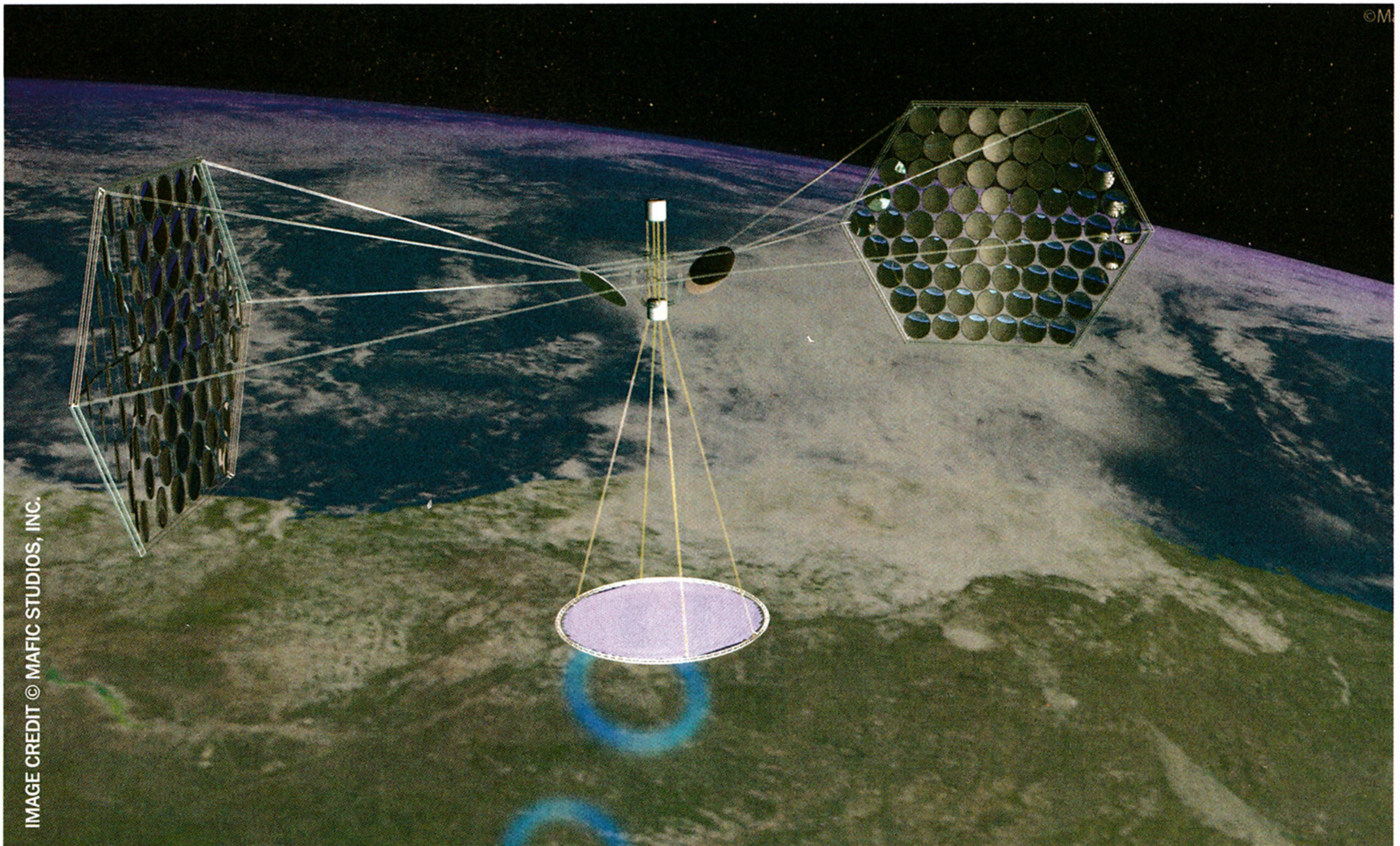


IMAGE CREDIT © MAFIC STUDIOS, INC.

Cutting-edge companies are planning to launch solar panel arrays into space to capture the rawest form of solar energy and send it back down to earth.

For those who believe space offers a brighter future and solutions for mankind's earthly problems such as energy security, sustainable development, and climate change, November 2011 was an exciting month.

The highlight was the November 14 press conference held at the National Press Club in Washington, D.C. to unveil the results of a three-year, 10-nation study by the International Academy of Astronautics (IAA) on space-based solar power (SSP).

NSS, which seeks a more prosperous future for humanity and the expansion of civilization beyond Earth, sees SSP as one important vector which could advance its vision of unlocking the vast resources of space for the dramatic betterment of mankind. NSS sponsored the press conference to highlight the IAA conclusions.

As advocates of a bright future for humanity, NSS felt the report was important and deserved public attention for several reasons.

First, the NSS campaign to get SSP included in the mainstream debate about national goals has been frequently met with objections from those who felt such an ambitious endeavor was technically infeasible. The inability of the advocates to point to a recent, credible source of information about the potential of SSP from within the technical community greatly hampered NSS' efforts. The IAA represents a major change in this regard, as it is recognized as the premier international technical merit society, founded by Theodore Von Karman, whose vision guided much of modern air and space development; presided over by the former head of the Indian Space Research Organization, Madhavan

Nair; and consistently producing quality and visionary work, such as its recent book on another subject of NSS interest, planetary defense. Many of our membership who comprehend the value of this ambitious idea now have the backing of international technical experts to assist them in their advocacy.

Second, the report makes claims that rightfully deserve the attention of policymakers, stating:

- "economically viable solar power satellites (SPS) appear achievable during the next 1-3 decades;"
- "solar power satellites appear to be technically feasible as soon as the coming 10-20 years using technologies existing now in the laboratory;"
- "there are no fundamental technical barriers that would prevent the realization of large-scale SPS platforms during the coming decades;"
- "no fundamental breakthroughs appear necessary and the degree of difficulty in projected R&D appears tractable;" and
- "no fundamental 'show-stoppers' among the required supporting systems."

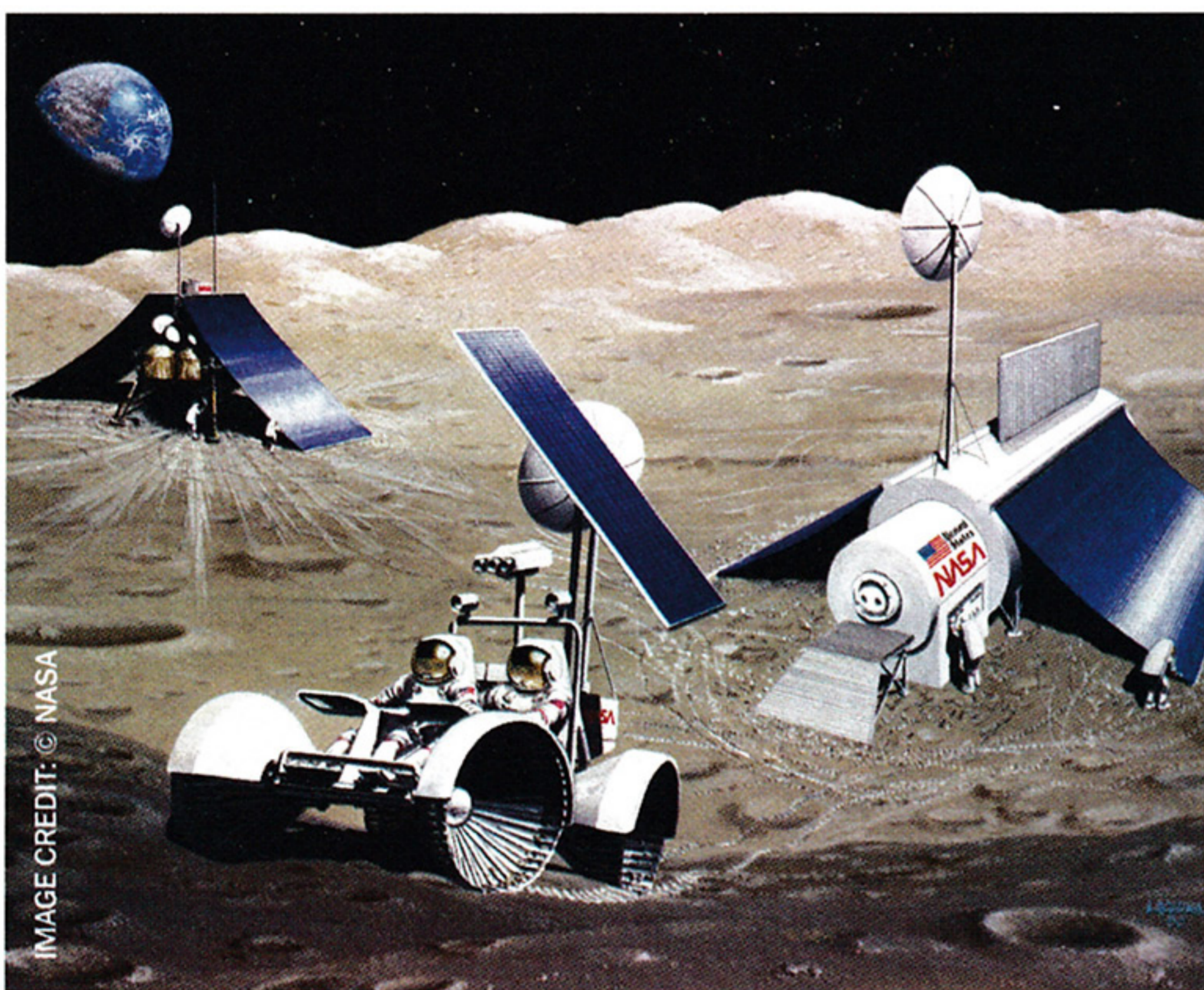
According to the IAA, the total amount of energy delivered by renewable sources must increase from roughly 12,000 billion kW-hours per year in 2010 to more than 110,000 billion kW-hours per year in 2030-2040, and to more than 430,000 billion kW-hours per year by 2100. The IAA estimates that should SPS achieve financial viability and full output,

"annual employment on the order of 5,000,000 individuals might be realized eventually."

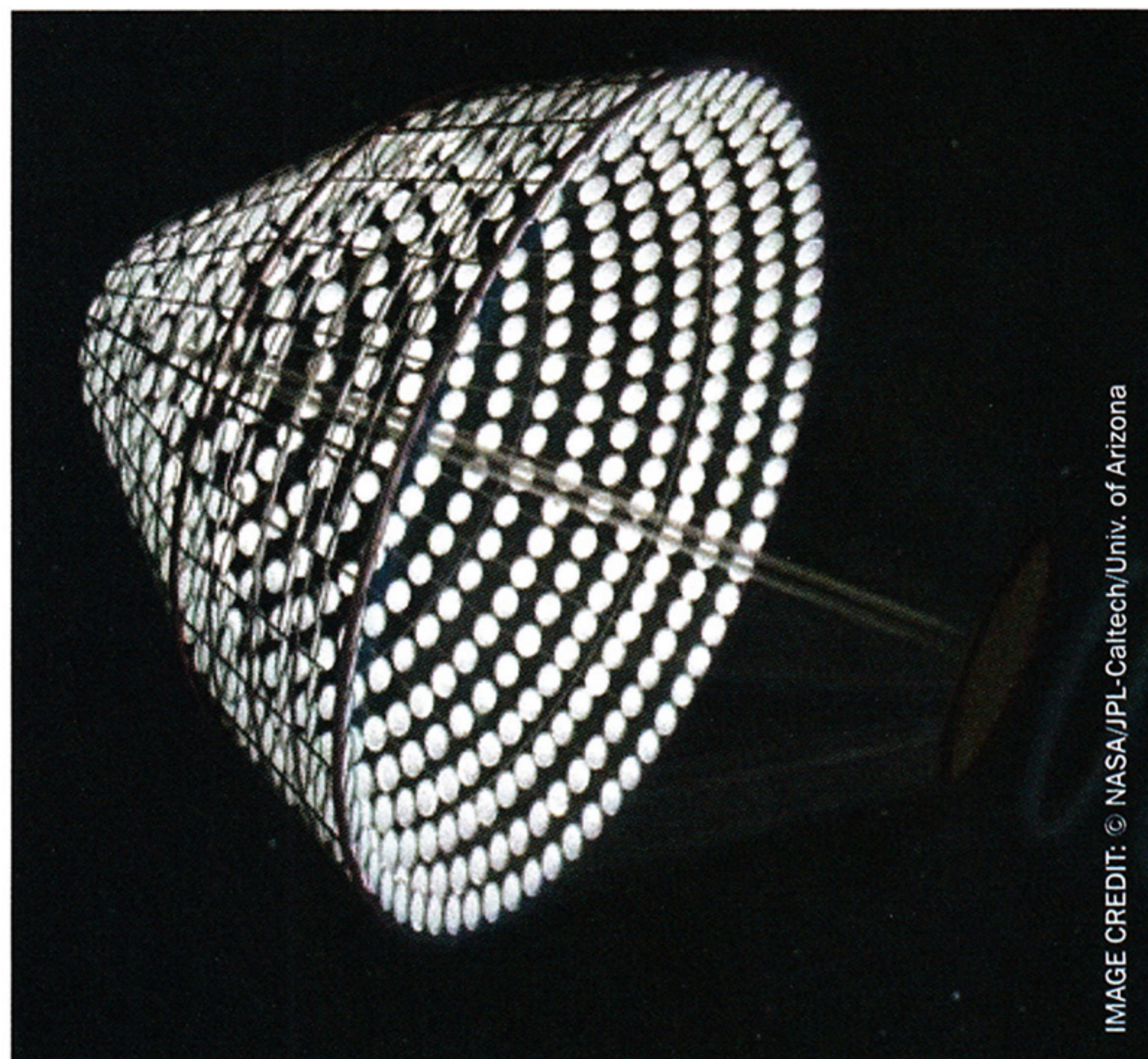
From an advocacy standpoint, it is important to note the IAA conclusion that, "as of 2010, the fundamental research to achieve technical feasibility for the SPS was already accomplished. Whether it requires 5-10 years or 20-30 years to mature the technologies for economically viable SPS now depends more on the development of appropriate platform systems concepts and the availability of adequate budgets." The IAA noted that "systems studies are not enough. Technology flight experiments to test critical technology elements and technology flight demonstrations that validate SPS systems concepts to a high level of maturity appear to be essential," and perhaps most important from a policymaking standpoint, that it was the "consensus of the IAA that significant progress could be accomplished during the next 10-15 years—leading to a large but sub-scale SPS pilot plant."

Third, given reports on the subject come infrequently (the last one was from the Pentagon in 2007), a failure to highlight IAA's would be a wasted opportunity to inject a proper space focus into the national political agenda. After all, shouldn't presidential candidates have a position on whether or not they support development of an idea that could fundamentally change humanity's relationship to space and open the door to the long-term possibility of virtually limitless green energy and create more than a million jobs?

The press conference was packed, and achieved the desired effect of broad national and international coverage, including terrific articles by Jim Wolf of Reuters, Frank Moring of "Aviation Week," and many others, all of whom are listed on the NSS Space Solar Power website. But the press conference was not the only important event. The joint NSS/IAA team worked to ensure the conclusions of the report were available to key members in the policy and business communities through a series of pre-briefs, including various executive branch agencies concerned with space policy. Within days of the announcement, the topic was picked up for debate in the D.C. think tank community. The American Security Project responded to the IAA report with a session to focus on its implications for energy security and U.S. competitiveness, and the Carnegie Endowment



This artist's concept shows the deployment of solar arrays, which convert sunlight into electricity, on an initial lunar camp of the future.



**SPS-ALPHA (Solar Power Satellite via Arbitrarily Large Phased Array)** is a novel, bio-mimetic approach to the challenge of SSP. If successful, this project will make possible the construction of huge platforms from tens of thousands of small elements that can deliver remotely and affordably tens to thousands of megawatts using wireless power transmission to markets on Earth and missions in space.

for International Peace held an event focusing on aspects of international cooperation and opportunities to advance it through major international strategic partnerships.

One actionable point of the study was a "notional international roadmap that might lead to the realization of this visionary concept." The IAA report said that within 15 years, the first meaningful prototype, approximately the mass of the International Space Station, could be in orbit, producing megawatts of power and delivering it in the range of \$1-5 per kilowatt-hour, and emplaced least expensively with existing launch vehicles at less than the cost of the International Space Station. For those looking for aerospace jobs, those desiring a Manhattan Project of Energy, and those seeing energy as the space race and Apollo project of our generation, that is quite a "shovel-ready" project.

It is now up to our various nations' policymakers and attentive public to do what they wish with the recommendations of the IAA report. The IAA affirmed that the issue is not technology, but organization of resources and political will.

Barely more than a month before the release of the IAA report, Professor Wang Xiji, one of the fathers of China's space program, argued for a major increase in resources for China's SSP at the China Energy Environment Summit, stating, "Whoever takes the lead in the development and utilization of clean and renewable energy and the space and aviation industry will be the world leader." NSS could not agree more.

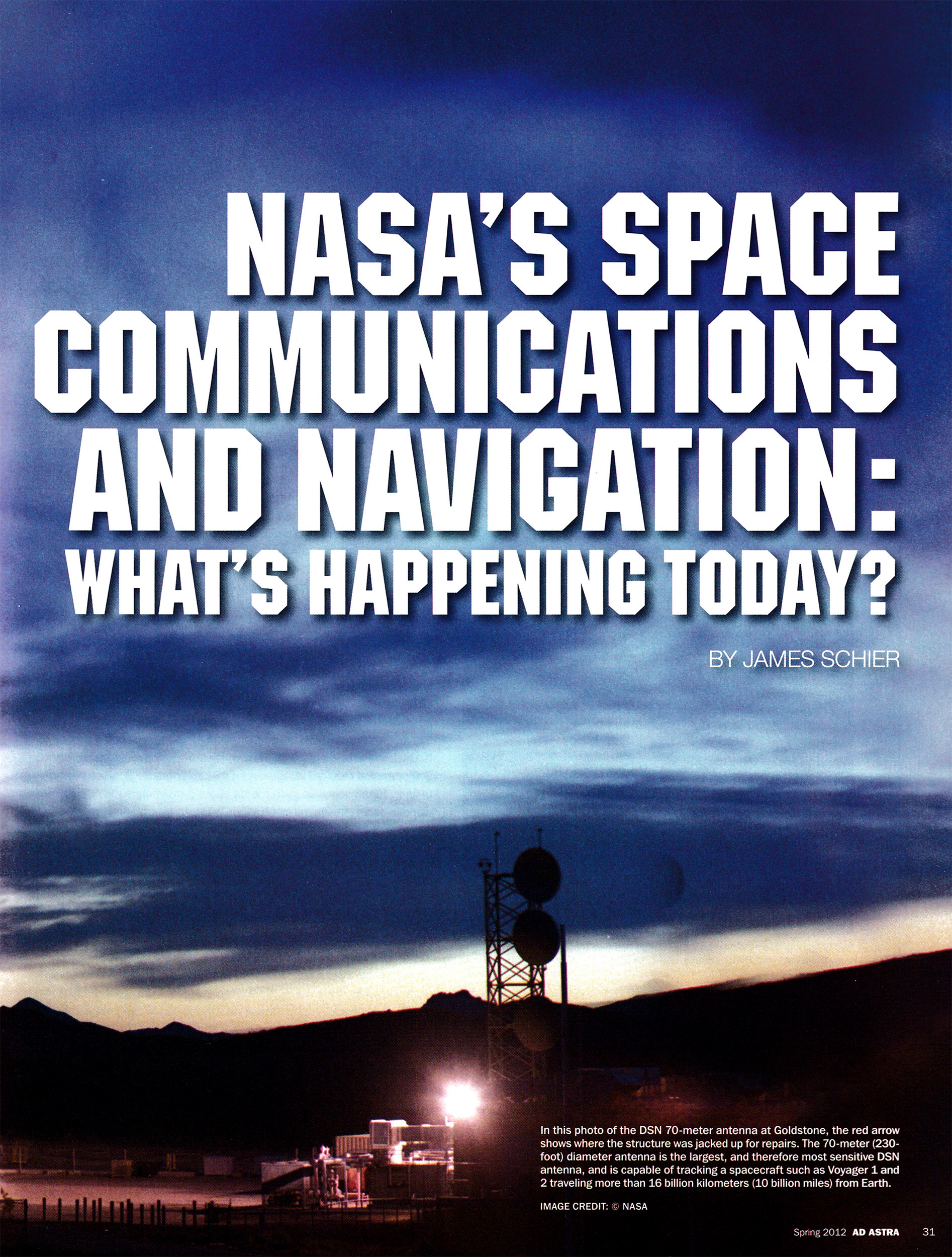
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*Peter Garretson has served as a member of the National Space Society Board of Directors, and was winner of the 2008 Space Pioneer Award for Space Development.*



# NASA'S SPACE COMMUNICATIONS AND NAVIGATION: WHAT'S HAPPENING TODAY?

BY JAMES SCHIER



In this photo of the DSN 70-meter antenna at Goldstone, the red arrow shows where the structure was jacked up for repairs. The 70-meter (230-foot) diameter antenna is the largest, and therefore most sensitive DSN antenna, and is capable of tracking a spacecraft such as Voyager 1 and 2 traveling more than 16 billion kilometers (10 billion miles) from Earth.

IMAGE CREDIT: © NASA

NASA's long-range vision for enhancing its three Space Communications and Navigation (SCaN) networks—the Near Earth Network (NEN), Deep Space Network (DSN), and Space Network (SN)—includes three efforts underway today:

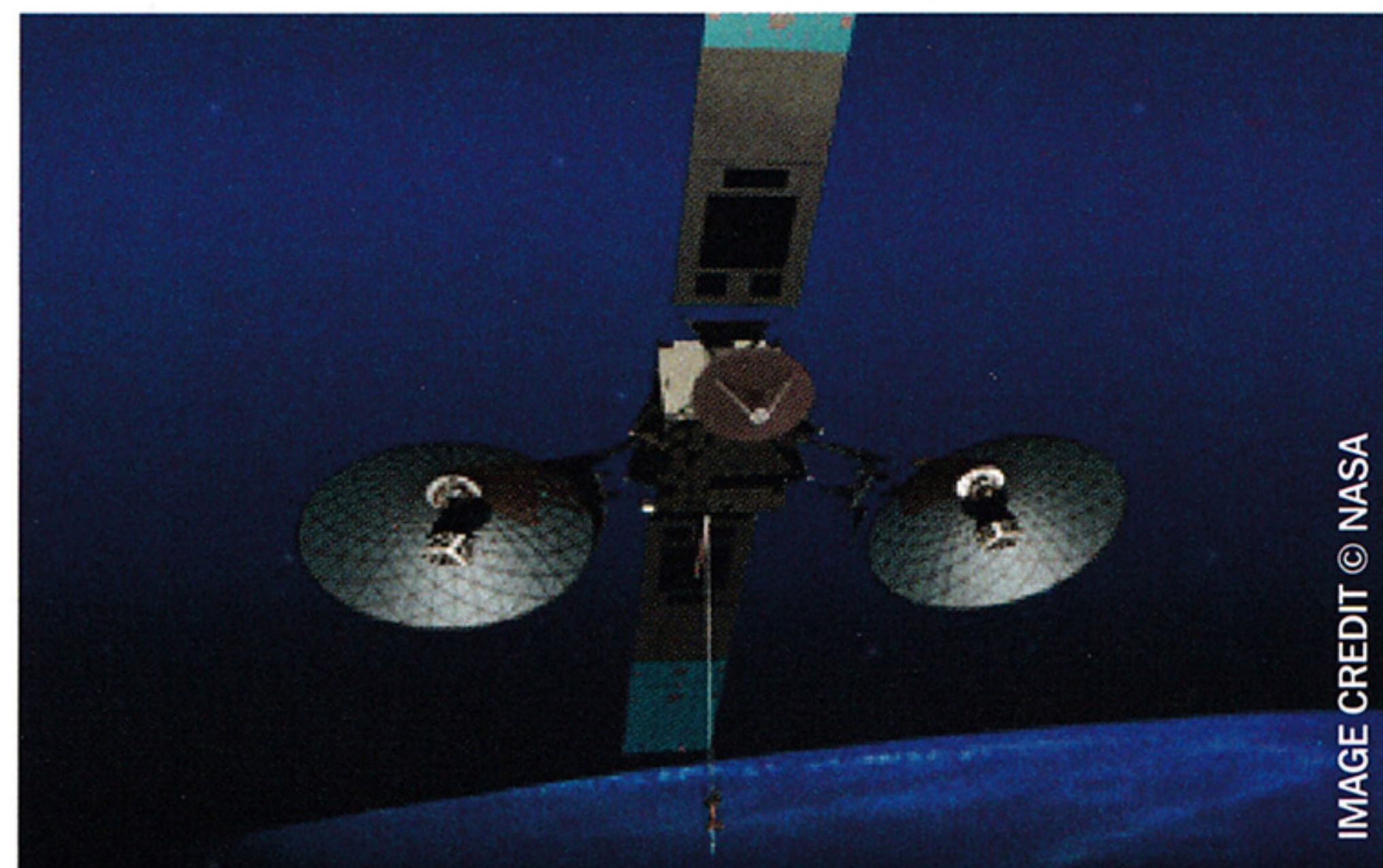
1. SN Modernization: A \$600 million project is replacing 30 year-old equipment to convert an old-fashioned analog design to a state-of-the-art digital design. Simultaneously, a \$1.5 billion project is buying three Tracking and Data Relay Satellites (TDRS) to replace aging 20 year-old satellites.
2. DSN Modernization: The 70-meter (230-foot) diameter deep space antennas are 40 years old and need an overhaul. The DSN recently completed major maintenance on the Goldstone, California antenna. In addition, a set of new 34-meter (111-foot) antennas is being built to enhance our deep space capabilities.
3. New laser communications (lasercom) technology: A \$226 million demonstration in 2016 was recently announced as a joint effort between SCaN and the Office of the Chief Technologist (OCT). A joint technology effort between the Massachusetts Institute of Technology, Goddard Space Flight Center (GSFC), and the Jet Propulsion Laboratory (JPL) will test lasercom for both near-Earth and deep-space applications.



Two SN ground terminals at the White Sands Complex (shown) plus one on Guam Island operate the TDRS satellite fleet. Credit: NASA/Goddard Space Flight Center.

## SN Modernization

The SN Ground Segment Sustainment (SGSS) project is redesigning two ground stations at the White Sands Complex in White Sands, New Mexico and a TDRS terminal on the island of Guam. First implemented in 1983, the equipment at these stations is becoming increasingly difficult to maintain, posing risks to the highly reliable service that has been provided for over two decades. SGSS' architecture will maintain that high level of service, accommodate new users and capabilities, and reduce maintenance



The TDRS-K satellite concept is shown above.

costs. SGSS will quadruple the data throughput from 300 million bits per second (Mbps) to 1200 Mbps via TDRS satellites enabling NASA to return more data from future science missions or support more missions. The architecture supports "plug and play" hardware that will enable the network to continue to grow.

SGSS must ensure uninterrupted service to current customers during the transition to the new architecture. The contract to build additional TDRS spacecraft, known as TDRS K, L, and M (the 11th, 12th, and 13th in the series) was awarded to Boeing Space and Intelligence Systems in December 2007. TDRS K will launch in 2012; TDRS L is scheduled for launch in 2013. The contract option for TDRS M was just funded and it should be launched in 2015.

## DSN Modernization: Major Maintenance on 70-Meter Antenna

Like an aging athlete whose joints need help, the giant antenna at NASA's DSN Goldstone site recently completed major surgery. The operation on the historic 70-meter (230-foot) antenna, which has received data from and sent commands to missions for more than 40 years, replaced a portion of the hydrostatic bearing assembly on which the antenna rotates horizontally. The operation required lifting about 4 million kilograms (9 million pounds) of finely tuned scientific instruments about 5 millimeters (0.2 inches) so workers could replace the steel runner, walls, and supporting grout.

Three steel pads support the weight of the antenna rotating structure, dish, and other equipment above the circular steel runner. A hydraulic system produces a film of oil about the thickness of a sheet of paper to float the three pads. After decades of constant use, oil had seeped through the runner joints, slowly degrading the structural integrity of the cement-based grout that supports it.

"As with any large, rotating structure that has operated almost 24 hours per day, seven days per week for over 40 years, we eventually have to replace major elements," said Wayne Sible, the network's deputy project manager at JPL. "We need to replace those worn parts so we can get another 20 years of valuable service from this national treasure." The repairs were featured on a recent episode of the National Geographic Channel's "World's Toughest Fixes."

Workers also replaced the elevation bearings, which enable the antenna to track up and down from the horizon. During repairs, the DSN continued to track deep space missions using the 70m antennas at complexes near Madrid, Spain, and Canberra, Australia.

This giant antenna was the first designed to receive weak signals and transmit very strong ones far out into space, featuring a 64-meter (210-foot) dish when it became operational in 1966. The dish was upgraded from 64 meters to 70 meters in 1988 to track NASA's Voyager 2 spacecraft as it encountered Neptune and Uranus.

## New 34-Meter Antennas

The DSN Aperture Enhancement Project will deploy two new antennas at Canberra, and develop three 80-kilowatt (kW) uplink systems at one 34-meter antenna at each of the DSN complexes at Canberra, Madrid, and Goldstone. Deployment will require building the supporting infrastructure, mechanical structures, and additional control equipment.

An array of four 34-meter antennas provides capabilities similar to a 70-meter antenna for a satellite downlinking its data to Earth. Each 34-meter antenna can also be used separately, freeing antennas when the 70-meter capability is not needed. More antennas can be added to keep increasing performance.

However, one consequence of mimicking the performance of a 70-meter antenna with four 34-meter antennas is that the transmitter power on one of the 34-meter antennas must be increased by a factor of four. Since the 70-meter antenna has a 20-kW transmitter, one of the new 34-meter antennas at each site must have an 80-kW transmitter.

Analysis of outer planet missions reveals a growing bias toward the southern hemisphere well into the 2020s. Mission tracking needs in the southern hemisphere will overload the existing capacity at Canberra by 2015. Currently, Canberra has the least number of assets (one 70-meter and two 34-meter antennas) resulting in no southern hemisphere backup capability for the 70-meter downlink. The two new antennas will provide additional DSN support in the southern hemisphere during this critical time frame.

Eventually, the DSN plans to add six new 34-meter antennas—three in Canberra, two in Madrid, and one in Goldstone—which will provide a total of four 34-meter antennas at each site. The Canberra antennas will be completed in 2014 and 2016. Construction has already begun on the first one. The 80-kW transmitters will be installed between 2015 and 2017. The remainder of the 34-meter antennas will be completed between 2018 and 2022.

## New Laser Communications Technology

The SCan program is collaborating with NASA OCT to sponsor the Laser Communications Relay Demonstration (LCRD), which will demonstrate reliable and cost-effective lasercom technology for near-Earth and deep-space systems.

Lasercom is a transformative technology enabling NASA, other government agencies, and the commercial space communications industry to undertake complex missions requiring increased data rates or decreased burdens for communications. For approximately the same mass, power, and volume, a lasercom system provides significantly higher data rates than a comparable radio frequency (RF) system.

Lasercom with data rates 10-100 times more than current RF systems may revolutionize space science and exploration. It will let missions use bandwidth-hungry instruments, such as hyperspectral imagers, synthetic aperture radar, and other instruments requiring high definition in spectral (lots of frequencies), spatial (lots of points in the sky), or temporal (lots of sensor samples per second) modes. Lasercom also makes "virtual

presence" possible, allowing future explorers to have real-time, high-definition video from an asteroid or the Moon.

"We always dreamed of having laser communications [that] could increase data rates by anywhere from 10 to 100 times," said Goddard Chief Scientist Jim Garvin, a long-time proponent of the technology. "We've been waiting for more than a decade."



DSN's Canberra Deep Space Communications Complex is shown at left and views of the new 34-meter antenna under construction at Canberra are shown at right.

For example, at the current limit of 6 Mbps for the Mars Reconnaissance Orbiter (MRO), it takes approximately 90 minutes to transmit a single High Resolution Imaging Science Experiment image to Earth. An equivalent MRO mission with lasercom would reduce that transmission time to about five minutes.

LCRD involves a hosted payload on a commercial satellite developed by Space Systems/Loral, of Palo Alto, California, and two specially equipped ground stations in California and Hawaii. Multiple ground stations are important for demonstrating a fully operational system in spite of cloud cover and atmospheric turbulence. LCRD is expected to launch in 2016 and operate for two to three years.

"We want to take NASA's communications capabilities to the next level," said LCRD Principal Investigator Dave Israel of NASA GSFC, who is leading the multi-organizational team that includes the JPL and MIT. Although NASA has developed data compression and other techniques to boost the amount of data that current systems can handle, its capabilities will not keep pace with the projected needs of advanced instruments and future human exploration, Israel added.

The payload will include telescopes, lasers, mirrors, detectors, a pointing-and-tracking system, and two types of modems. One modem is ideal for communicating with deep space missions or tiny, low-power satellites. The other modem can handle much higher data rates from Earth-orbiting spacecraft, including the International Space Station.

SCaN is already working with MIT to develop an initial lasercom payload for NASA's Lunar Atmosphere and Dust Environment Explorer (LADEE), launching in 2013. The main goal is proving lasercom concepts and transferring data at 622 Mbps—about five times the current capability. LADEE is equipped with only the lower-speed modem and is expected to operate for only 16 days.

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*James Schier is chief architect and planning systems manager for the Space Communications and Navigation program at NASA.*



# A NEW APOLLO- LEVEL SPACE AGE

BY BRUCE CORDELL

An artist rendition depicts past space accomplishments with Neil Armstrong and Buzz Aldrin's spacesuits from the 1969 Apollo 11 mission next to our future aspirations. In the foreground, NASA's Robonaut 2 points towards the proposed Ares V rocket, which will be able to lift more mass than any other launch vehicle in history. The futuristic spacecraft in the middle will be able to utilize oxygen produced on the Moon for propellant.

IMAGE CREDIT: © ERIC LONG/NATIONAL AIR AND SPACE MUSEUM  
IMAGE CREDIT: © NASA/ JOHN FRASSANITO AND ASSOCIATES



## Introduction

One of the great mysteries of the space age is why no one has visited the Moon in 40 years, or even ventured beyond Earth orbit. Some suggest it's because the world is afflicted by economic uncertainty, global disasters, and international terrorism. If so, how likely is it that President John F. Kennedy's 50 year-old vision of human expansion into space will rise again, in a few years, to dominate global headlines?

The "Maslow Window" model provides an empirical, long-term, global approach to a new understanding of how interest in space exploration and other macro-engineering projects ebb and flow. And it suggests that a near-term, JFK-style decade of interest and passion in space is likely.

Measureable trends over the last 200+ years—in the economy, technology, and geopolitics—point to the decade between 2015 and 2025 as likely to feature a major economic and exploration boom like the 1960s, accompanied by a Camelot-style zeitgeist. A renaissance like this is called a Maslow Window. Abraham Maslow (1908-1970) was an American psychologist who studied human performance and originated Maslow's hierarchy of needs, which states that people seek to cover basic physiological and safety-focused needs, followed by love/belonging and esteem needs, to ultimately reach self-realization—when they are able to focus on other things and their worldviews expand exponentially. Indeed, Maslow Windows explain our national romance with the Apollo Moon program in the 1960s, and society's waning interest in it in the 1970s. They also illuminate the probable timing and key drivers of events in our future with major implications for business, technology, and education.



On May 25, 1961, Kennedy announced his support for the Apollo program as part of a special address to a joint session of Congress:

## Pulsed Progress Over Two Centuries

Over the last 200 years, major events in human exploration (e.g., Lewis and Clark), massive state-of-the-art macro-engineering projects (e.g., Panama Canal), and exceptionally destructive wars (e.g., World War I) have clustered together, especially near times of major, twice-per-century economic booms.

For example, the most recent Maslow Window featured Apollo, considered by many to be the greatest exploratory and technological event in the history of the world. It began as a product of Cold War rivalries but was really made possible by the greatest economic boom up to that time.

As Mackenzie and Weisbrot wrote in 2009, "With wealth never before imagined, Americans could dream dreams never before possible... national optimism reached epidemic levels." However, as is typical for Maslow Windows, this ebullient feeling was cut short by the stress of a major war (Vietnam).

How important was the JFK boom to the Apollo program, both financially and politically? Could President Kennedy have successfully kicked off the Apollo program at any time other than the early 1960s? Could he have successfully motivated a large space program in the 1980s?

The historical experiment has already been done—by President Ronald Reagan, starting in 1984. Not even the Great Communicator himself, arguably as charismatic as JFK, could make the space station program happen during the decade after he proposed it. Indeed, in 1993, the U.S. House of Representatives came within one vote of cancelling the program. It was only after President Bill Clinton internationalized the space station that it became more politically viable, although not at Apollo levels.

The early 20th century Maslow Window (~1901-13) featured "pole mania" in the form of international races to claim discovery of the north and south poles, at the same time as the monumental construction of the Panama Canal ("Panama fever"). And including the Wright Brothers' first flights, the Great White Fleet's global voyage, the invention of the Model T, and Theodore Roosevelt as president, this transformative decade was one of the most ebullient in U.S. history. But, as in the 1960s, the epidemic of national optimism was terminated by a major war (World War I).

The early 20th century Maslow Window was preceded by the financial Panic of 1893 and the great 1890s recession. It lasted six years and was a "double-dip" that has parallels with the panic of 2008 and our slow recovery. Increasingly, economists compare today's economic and political situation with the 1890s, rather than with the Great Depression. The 1890s recession led to a recovery and boom that averaged 5 percent annual growth in the early 1900s. Assuming current policymakers are as smart and/or as lucky as those of the 1890s, this historical pattern points to the ignition of the next Maslow Window by mid-decade.

## Economic Booms are the Triggers

Macroeconomic data and global trends link great explorations, the largest macro-engineering projects, and even major wars with JFK-style economic booms over the last 200 years. A JFK-style boom provides resources for large engineering projects and human explorations, and creates a more exuberant population required for political support. As the prosperity spreads through society, many people become hopeful and enthusiastic and ascend the Maslow hierarchy. Their expanded worldviews make great explorations and macro-engineering projects seem not only intriguing, but almost irresistible. The ebullience is momentary, but typically very strong; Walter Cronkite's prediction that after Apollo 11, "everything else that has happened in our time is going to be an asterisk" is an example.

A fundamental reason we haven't returned to the Moon in 40 years is because there hasn't been a JFK-style economic boom spreading prosperity to all segments of society since the 1960s. But the long- and short-term indicators show the next one should arrive by mid-decade.

Another way to think of a Maslow Window is as a self-organized "critical state," like that of financial markets, earthquakes, and even wars, where a small change in the system may have a large, unpredictable effect. This explains why both "good" things (e.g., Apollo program, Peace Corps) and "bad" things (e.g., Cuban Missile Crisis, Vietnam War) seemed to happen rapid-fire during the 1960s' Apollo Maslow Window without much warning.

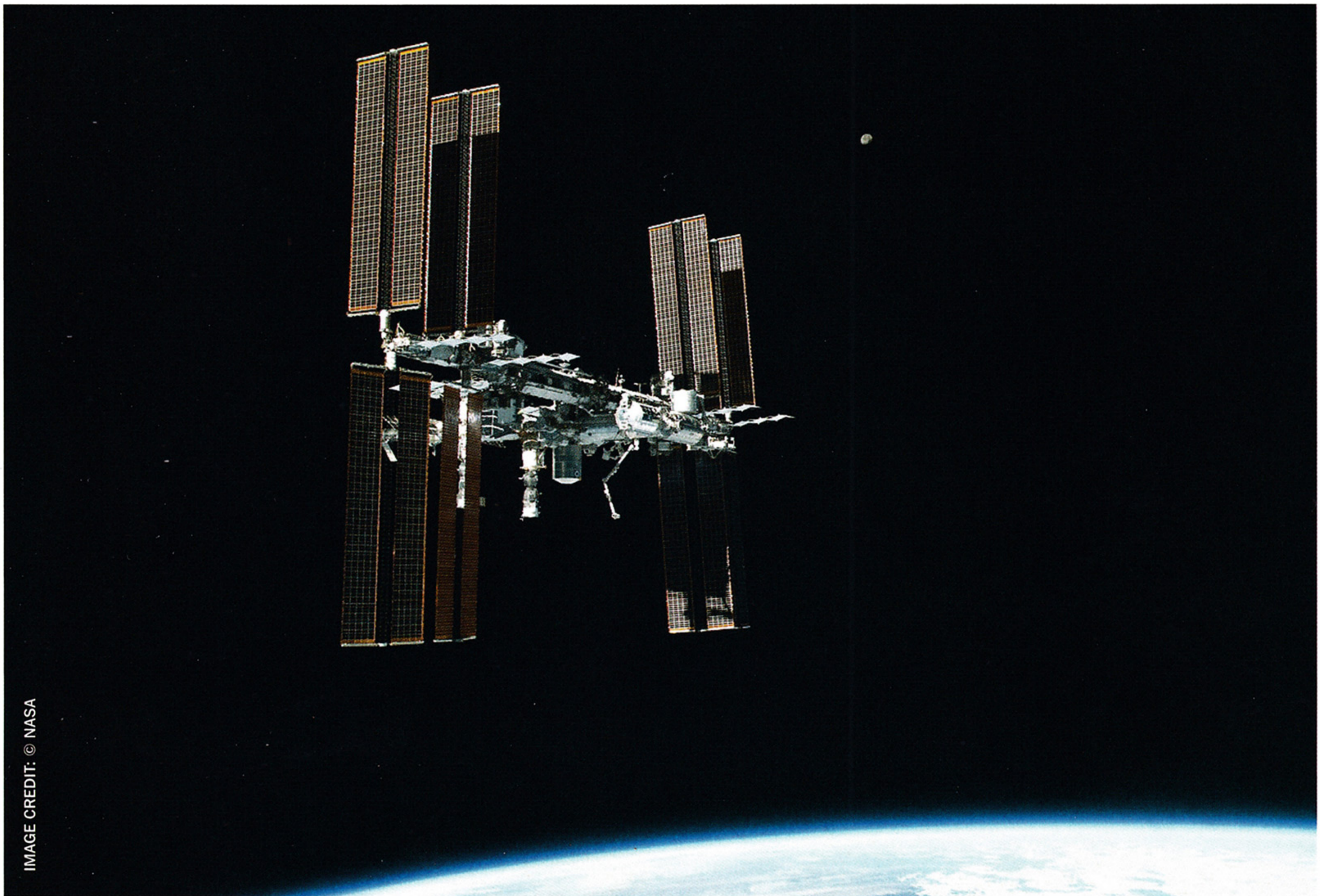


IMAGE CREDIT: © NASA

Photographed from the Space Shuttle Atlantis as the orbiting complex and the shuttle performed their relative separation in the early hours of July 19, 2011.

## Forecasting the New International Space Age

Maslow Windows are fundamentally driven by human nature and the basic laws of economics. Over the last two centuries, they have successfully operated through the greatest disasters such as the Civil War, the Panics/ Great Recessions of 1837 and 1893, the Great Depression, and two world wars. The likelihood of a technology and exploration boom by mid-decade is supported by centuries of historical data. Legitimate concerns like the financial panic of 2008, the recent recession, weak recovery, and declining education standards, are not evidence of America's imminent

collapse. Instead, they may signal the approach of the next Maslow Window. Historical analogs indicate that—during times similar to today—the widespread drive for prosperity results in a political realignment that triggers a new economic boom. With this possibility before us, it's important to remember that despite how things may look today, almost anything can happen tomorrow.

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*Bruce Cordell was formerly with General Dynamics in San Diego and is co-founder of 21stCenturyWaves.com, which monitors key events and global trends in the economy, technology, and geopolitics.*

## The basic lessons of the last 200+ years for great exploration and technology programs are clear:

- Expect the window to open near 2015: Maslow Windows seem to open unexpectedly because of pre-Maslow financial panics and great recessions. It's better to be ready to move quickly, like JFK when a decision about the Moon needed to be made. Our 21st century "Sputnik Moment" may be only a couple of years away.
- Expect the window to close by 2025: Maslow Windows are brief and vital critical states where almost anything can happen without much warning. Once the great boom begins it's always hard to imagine that

it will end. But it will, rapidly, usually in response to a war. If Vietnam had intensified in 1965 instead of 1968, we might have lost all of the Moon landings instead of only the last three.

- Achieve self-sufficiency in deep space: To avoid another 40 years trapped in Earth orbit, it's important to establish human bases on the Moon and/or near Mars that can operate without frequent re-supply from Earth. This should be a high priority during the new international Space Age because of the window's likely short lifetime.



# **STRETCHING THE BOUNDS OF INNOVATION: WHY NASA INVESTS IN THE TALENT OF TOMORROW, TODAY.**

BY MICHAEL T. WAGNER



# NASA sees a direct connection to tapping the bright minds of students to find solutions to challenges facing future generations.

Space, as understood in the 21st century, is a far more complex place than first imagined. Today we know that real dangers shoot across the universe, from asteroids that have the power to shift the balance of atmospheres, to our own space junk that bears the potential to destabilize the functionality of our orbital environment. Today we know that to reach Mars, one must not only build the fastest and furthest reaching space vehicle, but also protect humans inside from galactic radiation. And today we understand that the space race of this generation won't be to land on the Moon, but settle it.

Realizing that to remain at the forefront of engineering and science there must be a constant stream of exceptional talent, NASA reaches out to university students today, seeking out the mission architectures that will keep us on top of our game tomorrow.



The 2011 RASC-AL Forum First Place Winner, the University of Colorado, Boulder, stands together. Faculty Advisor Dr. Donna Gerren is holding their team's plaque.

## Creating a Launchpad for Success

From its inception more than 10 years ago, NASA's Revolutionary Aerospace Systems Concepts-Academic Linkage Competition (RASC-AL) has given definition to the early careers of engineers and scientists venturing into the world of aerospace exploration.

Yielding from public and private universities nationwide, undergraduate and graduate multidisciplinary teams develop groundbreaking concepts to meet the needs of tomorrow in space. Some teams even partner with international universities in South America, Europe, and Asia. Concepts are presented at the annual RASC-AL Forum in Cocoa Beach, Florida before a panel of NASA and industry experts.

Managed by the National Institute of Aerospace and sponsored by NASA's Human Exploration and Operations Mission Directorate (HEO), RASC-AL offers NASA access to new innovative ideas. NASA sponsors have actually incorporated RASC-AL concepts and designs into their real HEO planning, and have recruited RASC-AL participants for full-time employment based on the concepts they presented there. This includes former RASC-AL competitors like Sharon Jefferies, who is now a leading robotics expert;

Matt Simon, now a key member of NASA habitation teams; and Dave Reeves, who is now a go-to person for near-Earth object (NEO) and lunar exploration matters at NASA.

A committee of experts from NASA Langley Research Center divides the competition into four themes. In 2012, RASC-AL competitors will choose to address one of the following areas:

- NEO flexible mission architecture designs,
- Earth-orbit debris mitigation and satellite servicing missions,
- human-focused Mars mission systems and technologies, and
- lunar outpost-to-settlement architectures.

RASC-AL teams develop methods of achieving these goals while considering cost, space launch systems, and the ability to use both humans and robots during missions.

## NEO Flexible Mission Architecture Design

NASA is interested in mission designs that provide cost-effective means for both humans and robots to land on NEOs within the next 20 to 30 years. RASC-AL students are addressing this challenge by developing mission architectures that identify known NEOs and subsequently detail how to mitigate their danger.

These mission designs feature "innovative robotics system concepts" for capitalizing on the opportunity for exploration, science, and sample return from at least 10 cm below the surface of the object, and are encouraged to "include reusable elements to enable sustainable solar system exploration."

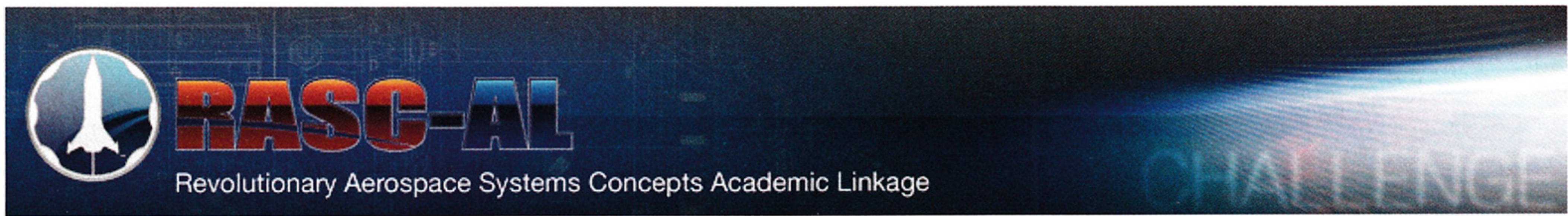
## Earth-Orbit Debris Mitigation and Satellite Servicing Missions

From communications to defense to research, the satellites that inhabit our orbital environment are crucial to life on 21st-century Earth. However, when incidents occur (e.g., parts break off or two objects collide and explode), debris clutters the immediate space above Earth. The danger with an over-crowded orbital environment is that each piece of "space junk" has the potential to damage, destroy, or knock a satellite out of orbit. An extremely overcrowded environment would inhibit all future space flight.

At RASC-AL, NASA seeks new technologies and mission concepts that would mitigate orbital debris by developing automated or even manned systems to remove debris from low, medium, and geosynchronous orbit. Comprehensive mission architectures include plans to rendezvous with functional satellites and other orbital installations for servicing missions.

## Human-Focused Mars Mission Systems and Technologies

Landing humans on the Red Planet is a long-term goal for NASA, but it is one that demands fundamental advances before it can be considered a viable target. RASC-AL teams consider a host of anticipated needs for a Martian mission, from developing a space launch system capable of getting us there to enduring long periods without communication with



Students and faculty advisors from all 18 participating teams gather with program staff for a final photo at the RASC-AL 2011 Forum in Cocoa Beach, Florida.

Earth and shielding against galactic radiation.

In 2012, the Mars theme includes a heavy astronaut health component, in which teams must contemplate advances in telemedicine, hygiene, and nutrition in deep space, exercise, and behavioral health.

## Lunar Outpost-to-Settlement Architectures

When the first astronauts landed on the Moon, they stayed for approximately two and a half hours. In the future, NASA astronauts will stay for much longer. To do this, NASA is designing lunar outpost architectures that provide a safe habitat for astronauts to live, work, experiment, and analyze samples.

RASC-AL students aide this process by developing fresh approaches to similar architectures, taking into account the full spectrum of needs required to make a lunar outpost a reality. These include the ability to localize energy production, minimize the use of consumables while there, and successfully store enough food to sustain human life.

Successful designs include advanced in-space transportation systems that reduce cost and improve safety, and designs for a lunar transportation

system. Going beyond the science and engineering feats of a lunar outpost, competing teams must also present a business plan on how to develop a lunar economy that utilizes lunar resources.

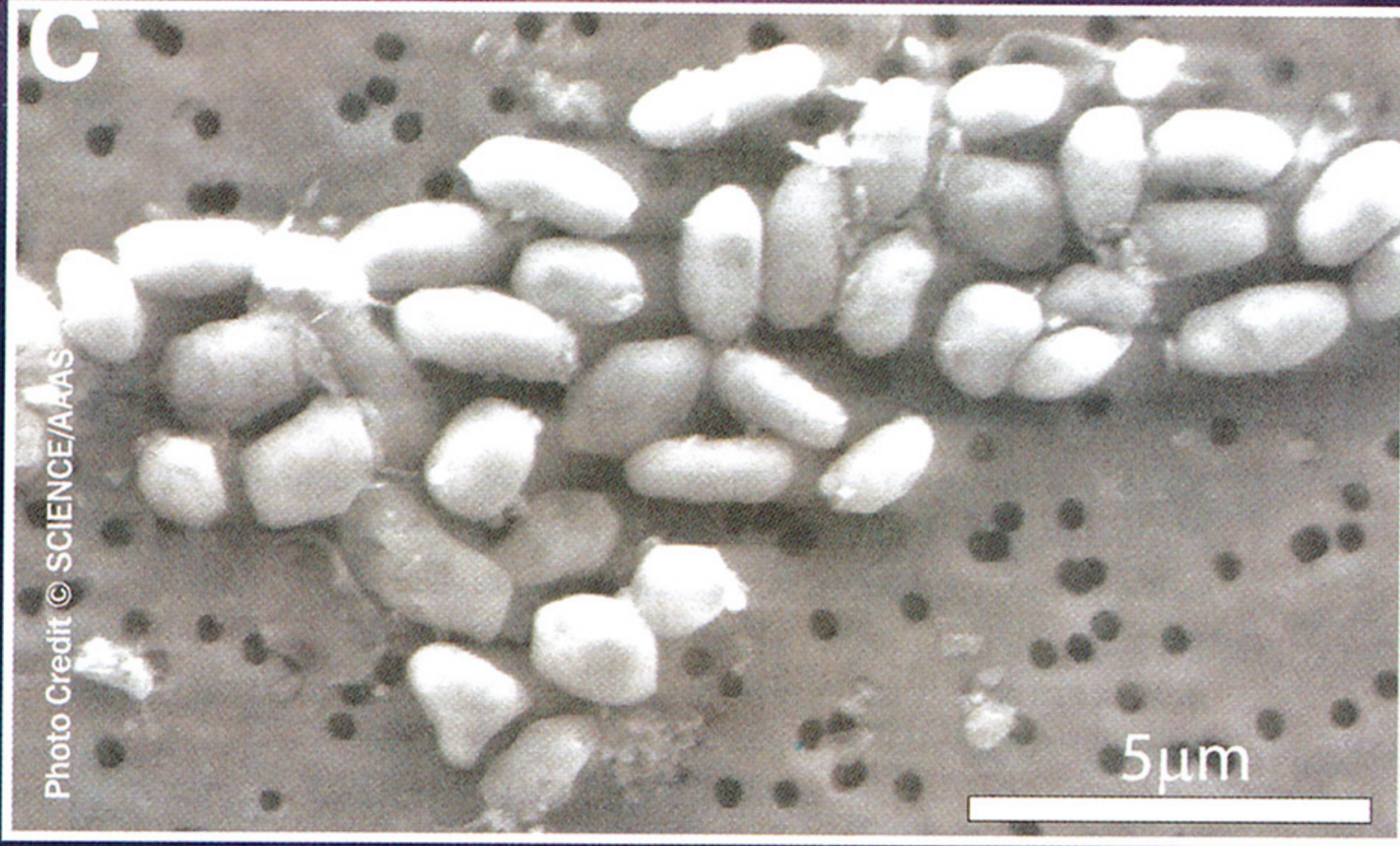
Realizing these missions will stretch the bounds of innovation, human health, and engineering, NASA sees direct connection to tapping the bright minds of undergraduate and graduate students—after all, finding solutions to these challenges will be the greatest feat of their generation.

*Michael T. Wagner is a NASA Langley Aerospace Student Scholar seated in the Office of Educational Outreach at the National Institute of Aerospace.*

For more information on RASC-AL, please visit [www.nianet.org/rascal](http://www.nianet.org/rascal).

Or, simply use this QR code:





Scanning electron micrograph of the GFAJ-1 strain of bacterium that has scientists debating new life forms.



# THE EVER-EXPANDING DEFINITION OF LIFE

BY ROBERT J. SAWYER

Of all the miracles portrayed on “Star Trek”—including warp drive, artificial gravity, transporters, holodecks, and phasers—one has always slipped by without so much as a raised Vulcan eyebrow: the ability to scan for and instantly detect alien life forms.

In fact, that may be the hardest one of all to make a reality, because we really don't have a good definition of life. And things got murkier on December 2, 2010, when NASA announced the discovery, right here on Earth, of a life form that can use arsenic instead of phosphorous as a nutrient and in its DNA.

We'd long assumed that the recipe for life anywhere in the universe was some combination of the elements carbon, hydrogen, nitrogen, oxygen, sulfur, and phosphorus. The ability to substitute arsenic for the last of these was a deeply resisted idea; a prominent British astrobiologist earlier this year announced at a meeting of the Royal Society, “You'd be off your trolley to go searching for arsenic-based life.”

But, really, it shouldn't have come as a surprise that arsenic could be used as a substitute for phosphorous. The two elements are in the same column on the periodic table, meaning they're chemically similar (just as silicon—an element often suggested as an alternative to carbon in science-fiction stories—shares a column with carbon).

Of course, the discovery of the bacteria GFAJ-1, in California's Mono Lake, isn't quite as exciting as finding silicon-based life would be. The term “organic chemistry,” which we so often use as a synonym for life, simply refers to reactions based on carbon compounds; phosphorous and arsenic are much less central to the notion of life than is carbon, and GFAJ-1 is still carbon-based. Those burbling that finding this microbe is like finding “Star Trek's” silicon-based Horta are overstating the case.

Still, the more possible rolls of the chemical dice there are that can come up snake eyes (or any other complex biological structure!), the better the chances are that E.T.s do exist.



Felisa Wolfe-Simon processing mud from Mono Lake to inoculate media to grow microbes on arsenic.

So, yes, the discovery of GFAJ-1 isn't as big a story as perhaps NASA's initial hype suggested: They dangled the possibility that extraterrestrial life had actually been found, and, of course, it hasn't. Still, the term so often used in astrobiology circles is “life as we know it,” or LAWKI. We now know of stranger life than we did before; our definition of life is indeed expanding.

Since arsenic was plentiful on the primordial Earth, it's possible that GFAJ-1's ability to use it is a holdover from the ancestral form: It may be that our

ancestors started out using arsenic and then transitioned to exclusively using phosphorous instead.

Or there's a remote possibility that GFAJ-1 is indeed alien life that dropped here on a meteor.

Or it may be that instead of just one common ancestor for all life on Earth, there were multiple ones, and GFAJ-1 is part of a separate lineage. Old Darwin himself alluded to the possibility of a “shadow biosphere” of alternative life forms in the final paragraph of the first edition of “The Origin of Species”: “There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one ...” But even if GFAJ-1 does turn out to be just our distant cousin, not something wholly different, we should redouble the efforts to see if there is a shadow biosphere (or “Life 2.0,” as physicist Paul Davies, a mentor to GFAJ-1 discoverer Felisa Wolfe-Simon, likes to call it) here on Earth.

As Mr. Spock would say, it's time to recalibrate the life-form sensors—and we need to keep on scanning.

---

*Hugo Award-winning science fiction writer Robert J. Sawyer is the author of the WWW trilogy consisting of “Wake,” “Watch,” and “Wonder.” His website is <http://sfwriter.com>.*

# KEPLER SPACE INSTITUTE AND THE NATIONAL SPACE SOCIETY HONOR DR. ESHEL BEN-JACOB

BY WALTER PUTNAM

The worlds of outer space and inner space met as Kepler Space Institute (KSI) awarded an honorary PhD to Professor Eshel Ben-Jacob, an award-winning Israeli scientist who is a pioneer in the study of bacterial intelligence.

In a special ceremony at the University of California, San Diego, on September 23, 2011, the National Space Society's Mark Hopkins participated in awarding Dr. Ben-Jacob the Doctor Philosophiae Honoris Causa, as NSS joined the KSI to honor one of the world's leading Earth and space sciences scholars.

Dr. Ben-Jacob, the Maguy-Glass professor of physics of complex systems at Tel Aviv University, has advanced the scientific understanding of cognition and intelligence through research on the collective behavior of microbes. His findings have led to studies of the ability of microorganisms to communicate, opening new doors in fields such as computing and social networking.

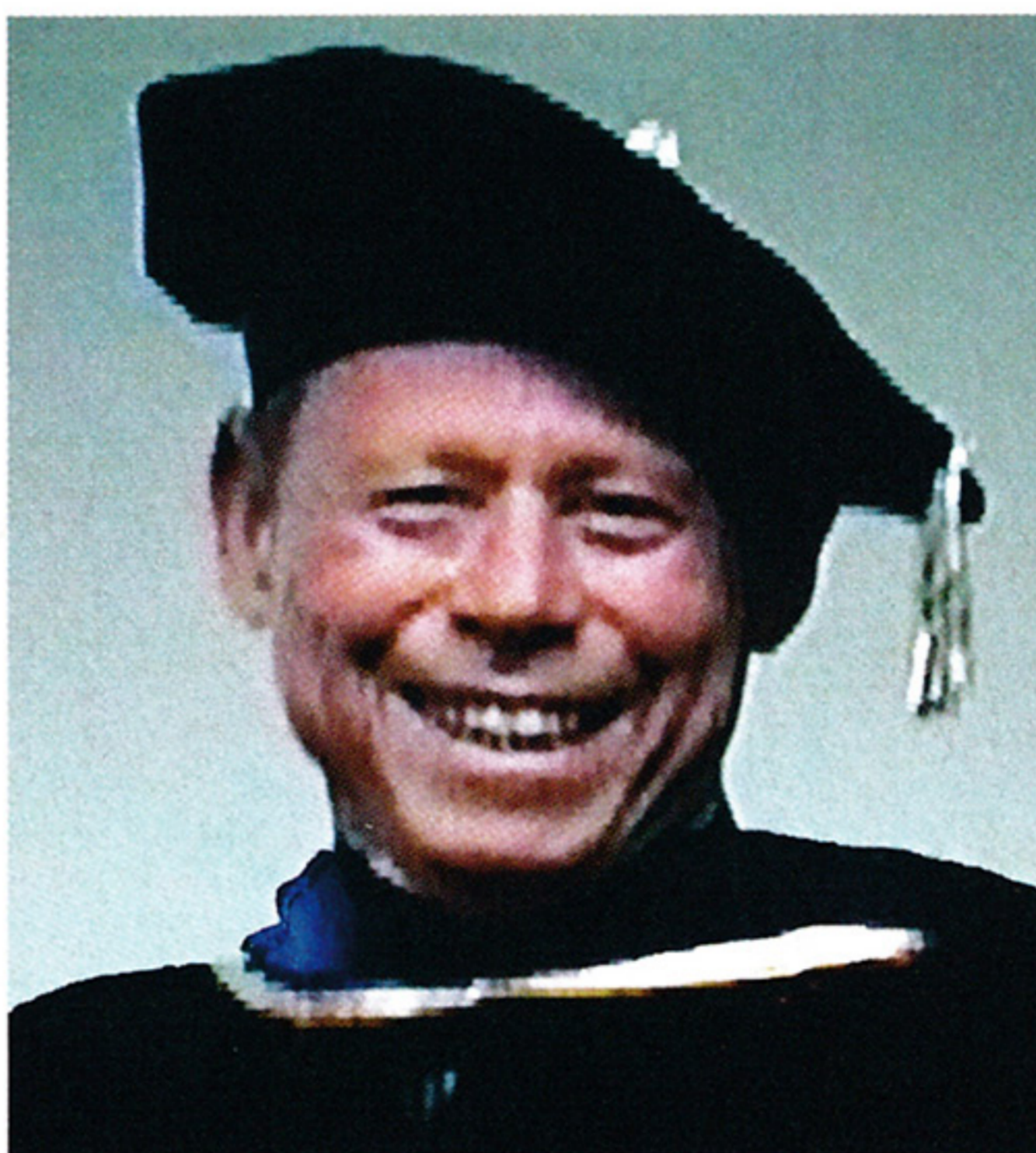
Dr. Ben-Jacob's investigations of live neural networks outside the brain led to the neuro-memory chip, recognized by "Scientific American" in 2007 as one of the 50 most important achievements in science and technology that year. "Eshel's pioneering research has put him in the arena of world class scientists," said Dr. Bob Krone, provost of KSI.

Mark Hopkins, chairman of the National Space Society's executive committee, noted that the professor shares the vision of NSS and KSI of tapping solar energy and other resources of extraterrestrial space to advance human civilization.

"There are those who prophesize doom and gloom. There are those that say we're going to have a lower standard of living in the future," Hopkins said. "There are those who prophesize resource wars because of the scarcity of resources. None of these need to happen because humans can claim the resources of space. Eshel Ben-Jacob, Kepler Space Institute and the National Space Society all realize that because of these resources we can have a prosperous and hopeful future for all humanity."

Dr. Krone underscored Hopkins' comments with remarks on the Law of Space Abundance, a term he coined. "All the resources that humans need now or that we can forecast into the future lie in space," he said.

Dr. Ben-Jacob's work is recognized for developing innovative ideas to fight disease-causing organisms and adapting friendly bacteria for human



Dr. Eshel Ben Jacob

benefit in space voyages. "If we seek a future for the human race in space, we must take bacteria along for the ride, as no other can prepare the setting for us," Dr. Ben-Jacob wrote in a chapter in "Beyond Earth: The Future of Humans in Space (2006)," a compendium of scientific, philosophical, and sociological thought. Dr. Ben-Jacob wrote that bacteria "invented the foundation of intelligence and sociality" that enables organisms "to conduct a dialogue for collective decision-making and to generate communal memory to learn from past experience." As this article goes to press, the results of a sequel investigation involving a previously unknown and surprising collaboration between swarming bacteria and fungi has been accepted for publication in the "Proceedings of the National Academy of Sciences."

During the degree ceremony, Dr. Ben-Jacob displayed movies of bacteria, as seen through a microscope, advancing as a colony to absorb food particles. In one scene, the microbes divided into different columns to surround and engulf three separate food sources. The slide illustrated how even these microorganisms must communicate to navigate as a group and achieve a common purpose.

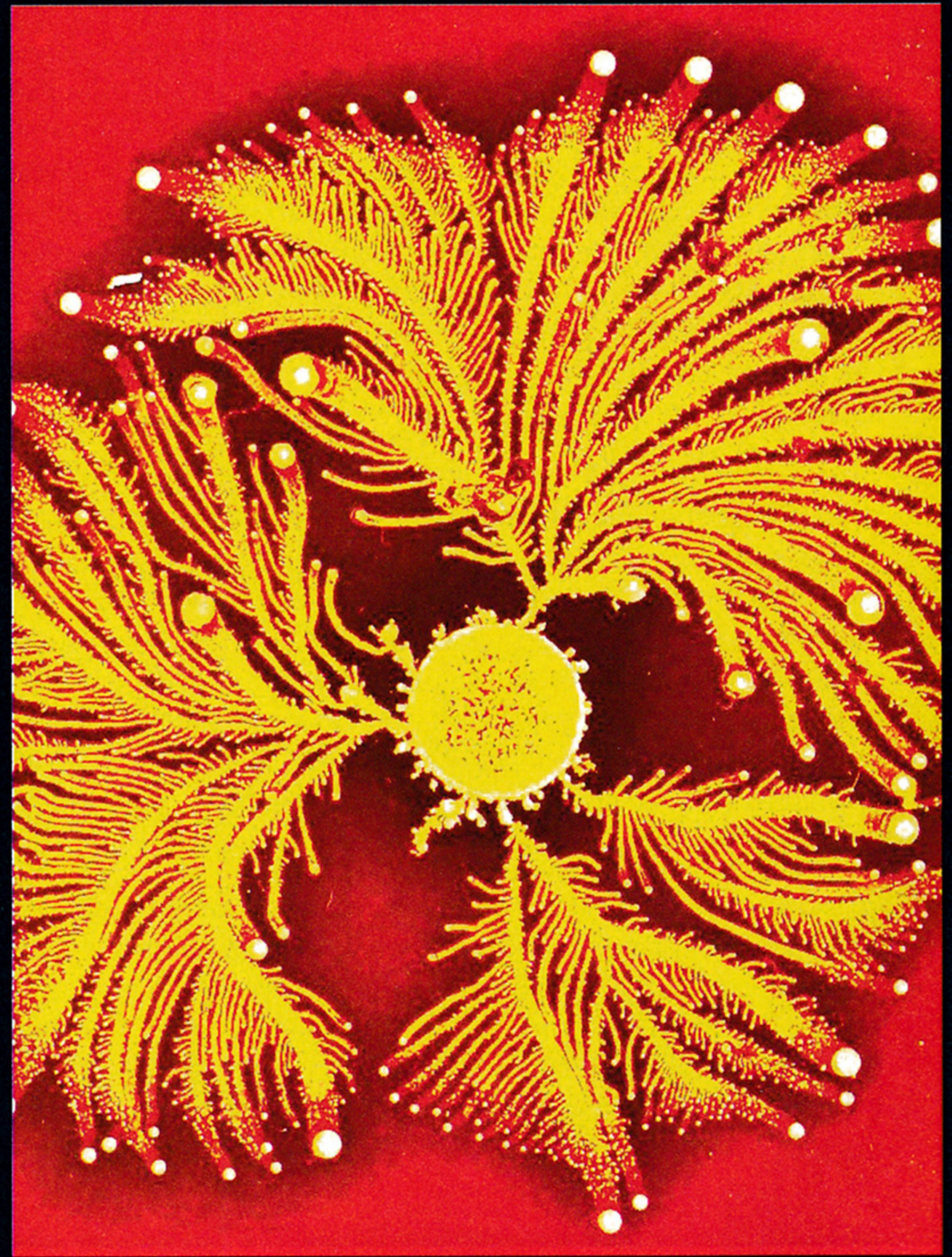
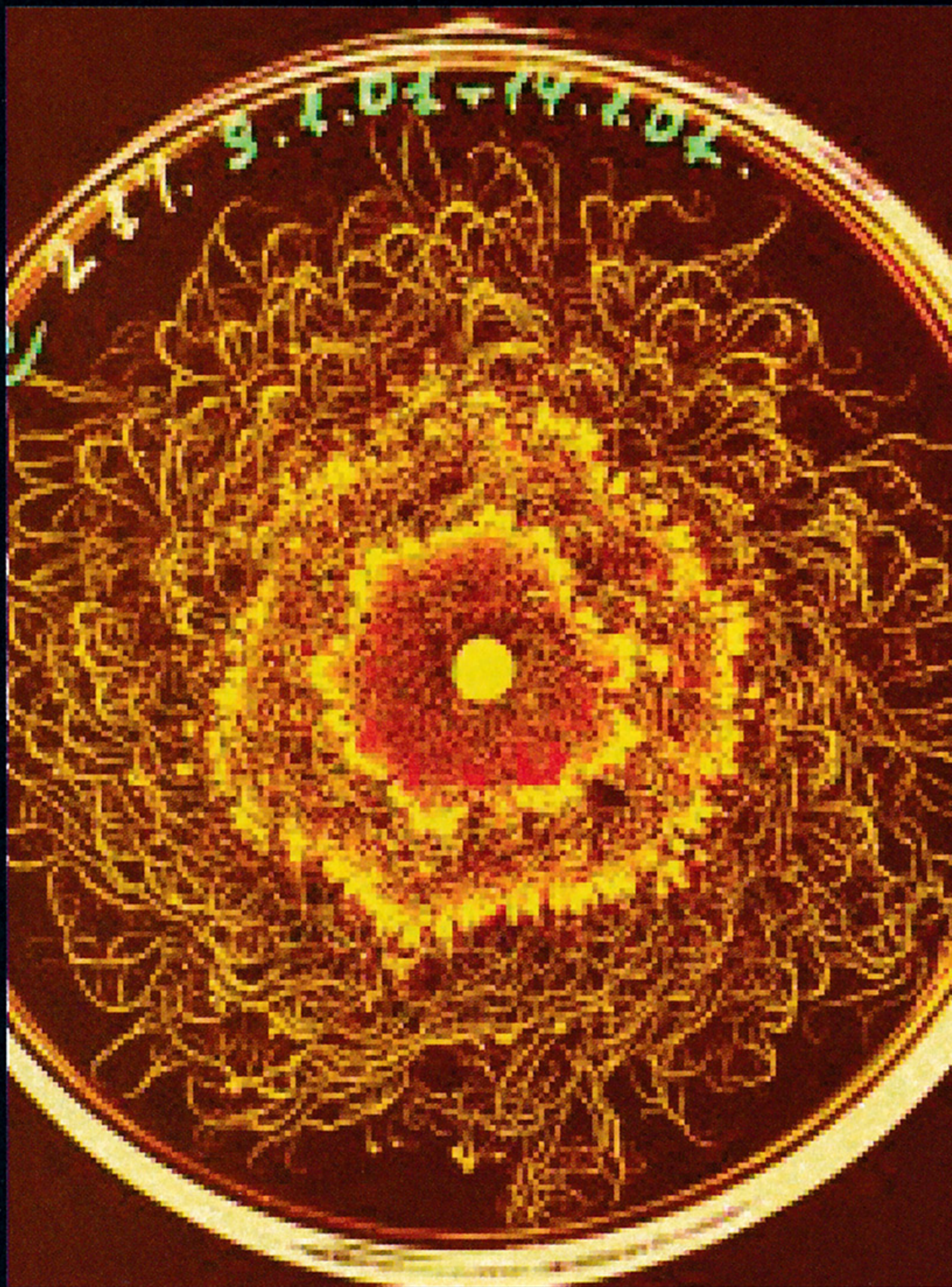
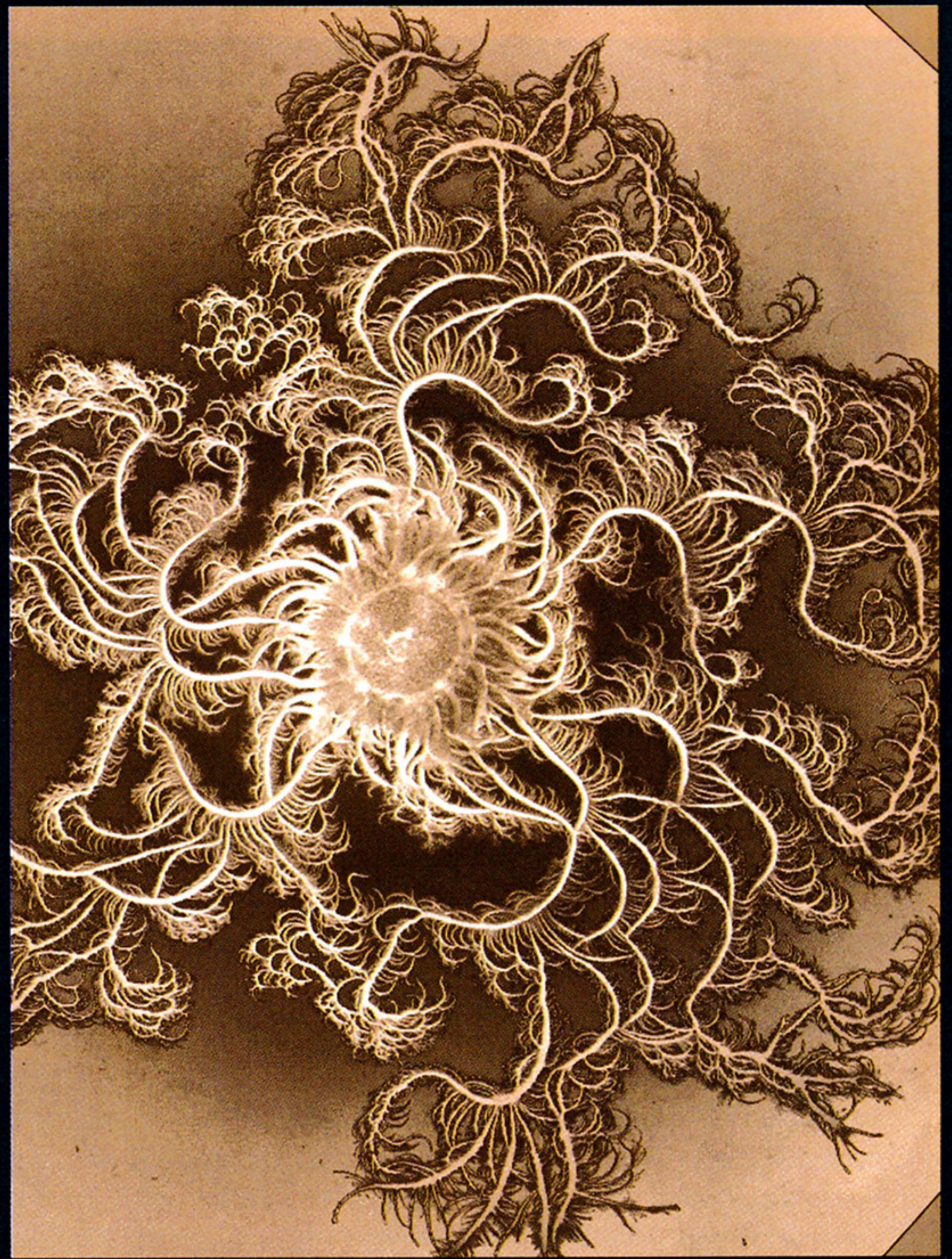
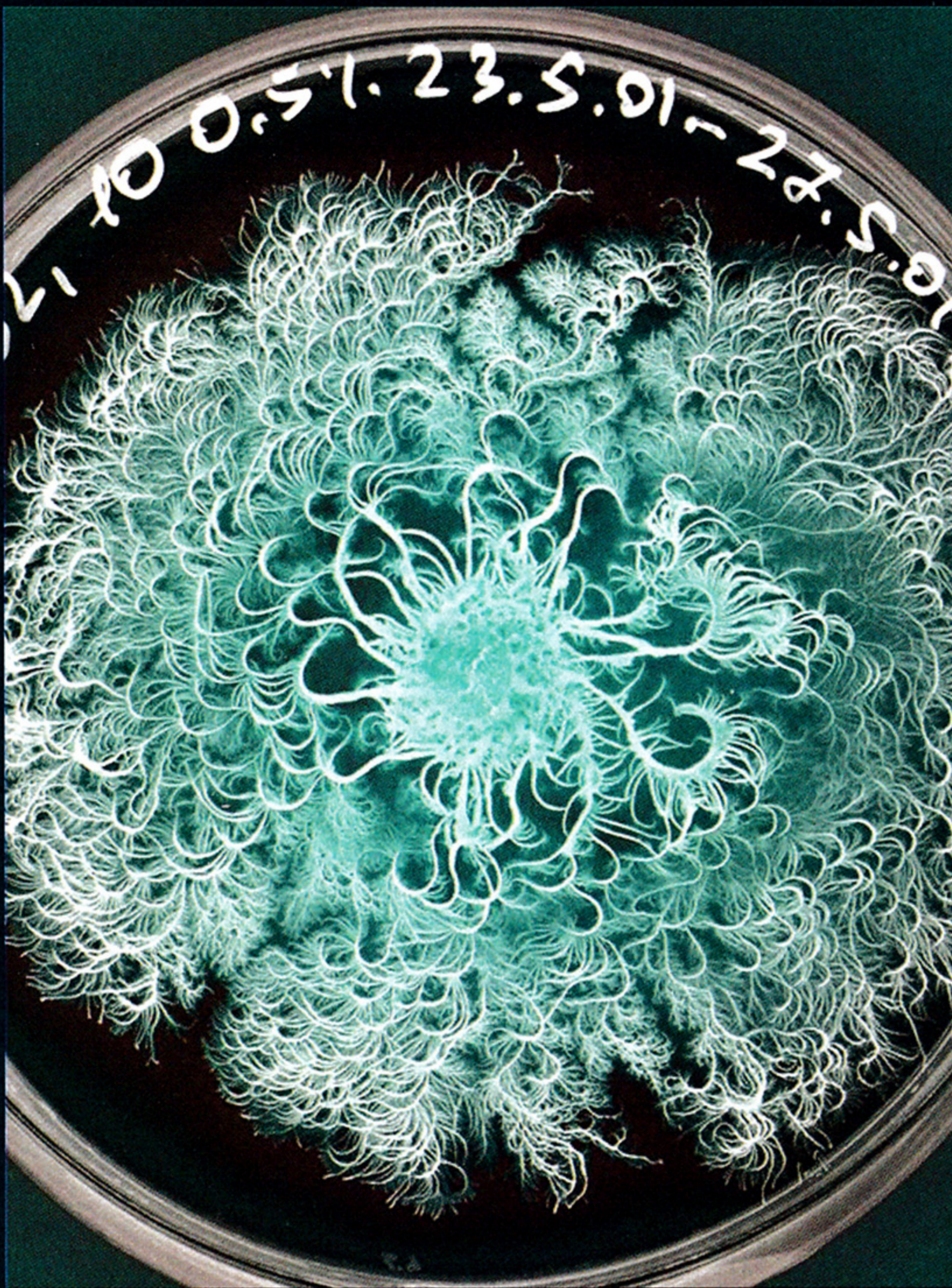
The degree presented to Dr. Ben-Jacob is only the second honorary PhD conferred by KSI, a global research think tank and online academy dedicated to the advancement of civilization through space exploration and development. The only other honorary degree went to filmmaker Irvin Kershner, director of "Star Wars Episode V: The Empire Strikes Back" and numerous other motion pictures. The honorary doctor of visual arts degree was conferred on Kershner in a ceremony at his Los Angeles home just weeks before his death on November 27, 2010 at the age of 87.

KSI and NSS are proud to collaborate on this award to Dr. Ben-Jacob and will co-sponsor KSI's space conference at Hilton Head Island, S.C., March 14-16, 2012.

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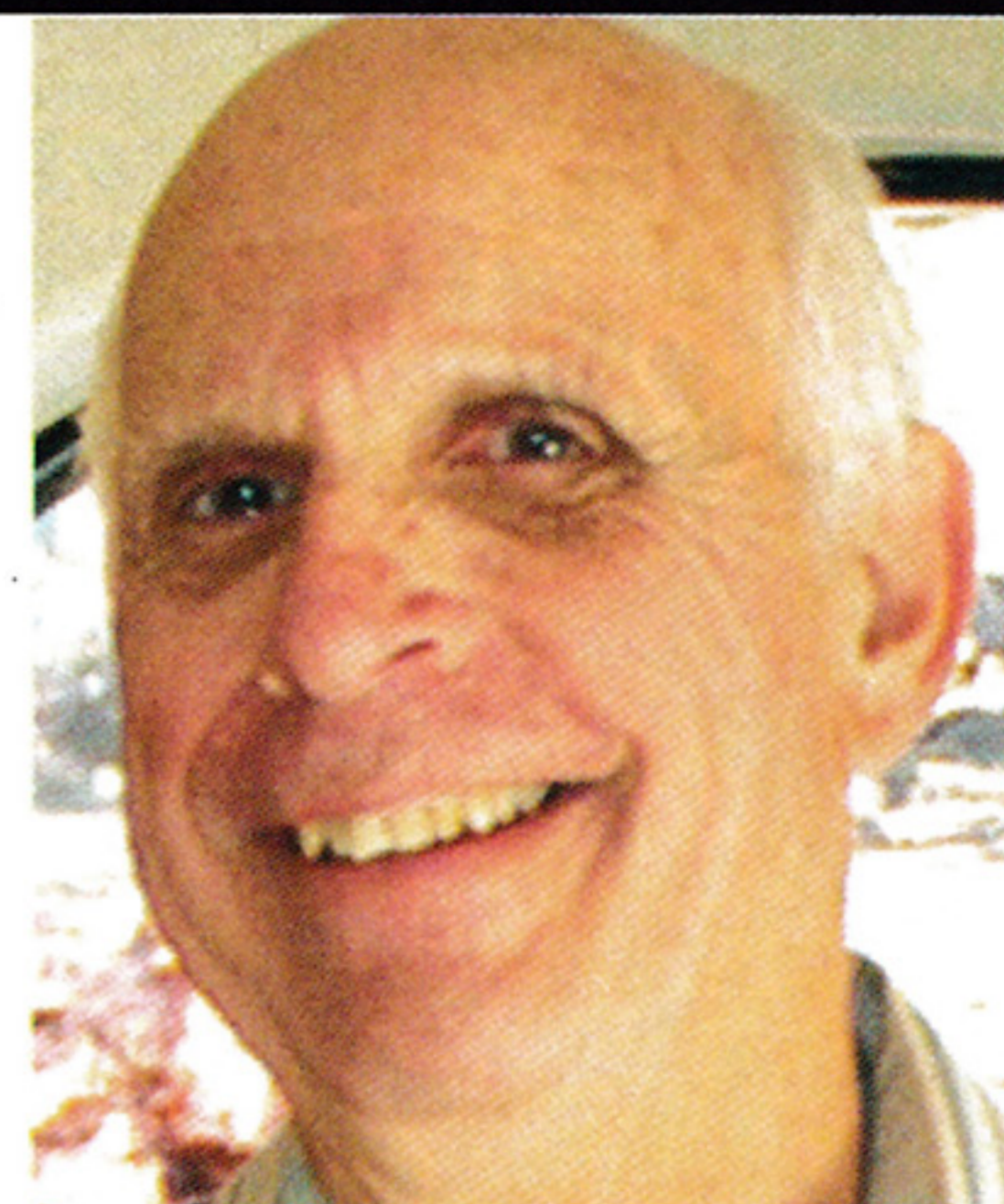
Read Dr. Ben-Jacob's full article in the "Proceedings of the National Academy of Sciences" here: <http://www.pnas.org/content/early/2011/11/16/1102097108>.

Walter Putnam, a journalist who retired in 2009 after a 30-year career with the Associated Press, is Kepler Space Institute's Dean of Communications.



Scientists studying how bacteria under stress collectively weigh and initiate different survival strategies say they have gained new insights into how humans make strategic decisions that affect their health, wealth, and the fate of others in society. IMAGE CREDIT © Eshel Ben Jacob

# THE LAW OF SPACE ABUNDANCE AND LUNAR CRATERSVILLE



**“The vast majority of the resources of the Solar System are in space—not on Earth.”**

- Mark Hopkins, chairman of the executive committee, National Space Society, “Ad Astra,” Spring 2011

“Space offers unbounded resources to meet human needs.” That wording for the definition of the Law of Space Abundance was created in July 2009 by the leadership of Kepler Space Institute and University. That law was not the result of any legislative process. It was the logical conclusion from centuries of humans perceiving value in the heavens, from five centuries of astronomical research and from 50 years of humans experiencing space. It is a natural law of our solar system and the universe beyond, reflecting the benefits Earth has already received from space exploration and development—but promising exponentially more.

The quantity of space-based resources waiting for the means to deliver to Earth is huge. However, a case can already be made for delivering oxygen, the heavy part of rocket fuel, from the Moon to Earth orbit. “Cratersville and Goddardsville: Circa 2069,” one of the two technical feasibility award winners in SHIFTBoston’s 2010 Moon Capitol architectural contest, was produced by “Team Goddard,” an eight-person interdisciplinary team led by sociologist John M. Wilkes of Worcester Polytechnic Institute (WPI) and Worcester architect Dan Benoit. Several WPI students later went through all 102 entries and decided that this best envisioned, “What should be happening on the Moon a century after the Apollo landings in 2069?”

What distinguished Team Goddard was that it set the task of designing a lunar base for 60 people at the lunar south pole that could pay for and feed itself. This level of self-sufficiency was not required by the contest and the other entries were not part of an economic trading system. Cratersville was a mining camp that provided liquid oxygen to orbiting fuel depots in lunar and Earth orbit, and delivered Helium-3 (fusion reactor fuel) to Earth. In order for the lunar operation’s labor requirements to be met, “Goddardsville” was needed on Earth.

This town near Boston would be mission control for a fleet of 300-350 lunar robots created and operated by a work force of 1,000 people whose jobs were on the Moon though they were physically on Earth. About 60 of them would serve on the Moon for a staggered 12-month deployment each year. This would not be a colony in the full sense of the word as families did not deploy together. Cratersville would not be modular, designed to grow from 60 to 6,000 in 100 years. Fifth of the

first 350 robots would be assigned to expand the base or build other excavation and fabrication robots. Goddardsville would have to keep pace and become 100 times larger as well, ending up like Star City near Moscow.

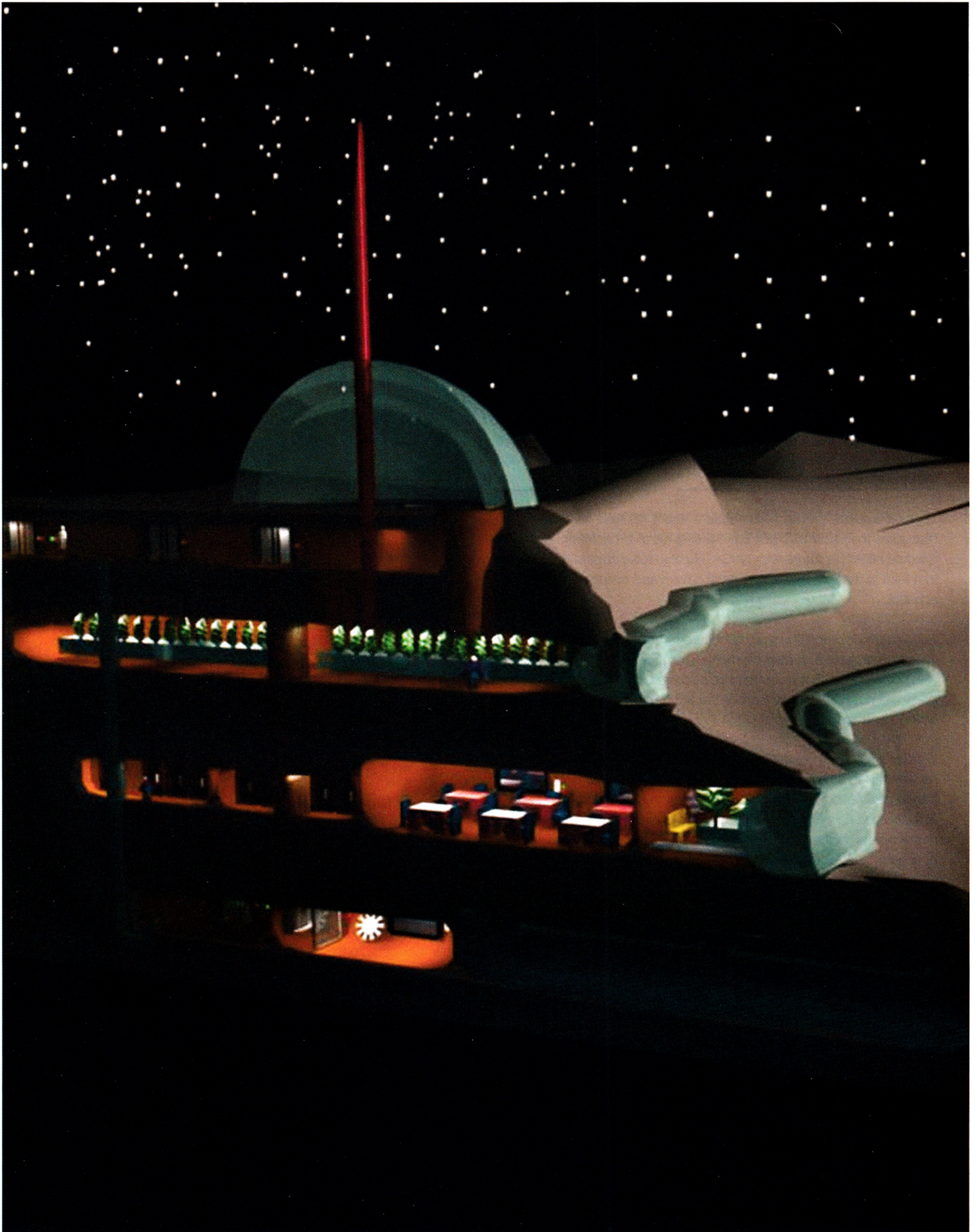
In “Strategic Thinking for Space Settlements: Energy from Space” (2006, Bob Krone, Ed., Beyond Earth: The Future of Humans in Space, Apogee Space Press, pp. 162-168), Dr. Paul J. Werbos of the National Science Foundation wrote, “Human presence in space will not be truly sustainable until it is capable of independent economic growth, without needing any net subsidy at all from government, and without being limited by the current rate of growth on Earth itself. There are three main requirements that need to be met: 1) money earned by space [revenue] must grow enough to be able to pay for the entire activity; 2) activities in space must be large enough and diverse enough that they lead to ‘multiplier effects,’ where people will invest ever more money to support new activities paid for by supplying existing activities and people in space; and 3) the underlying technology for productive activities in space must be efficient enough that we can ‘close the loop’ economically.

“We need instead to minimize the cost and time between now and our average best guess of the time when our enabling technologies, discoveries, and infrastructure will truly allow profit-making entities aimed at real public market to ‘take over—to operate on a large enough scale, with diverse enough activity, that they truly possess self-sustaining growth in service to humanity.”

When we go into space, we will establish a link between exponentially growing scientific knowledge, engineering expertise, and the unlimited energy and material resources of space. This linkage will have profound beneficial effects for all humankind, provided that the problem-solving expertise of our government institutions can successfully shepherd this marvelous advantage within the Law of Space Abundance for the benefit of humankind.

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*Bob Krone, PhD, is provost of Kepler Space Institute (KSI), a global research think tank and online academy. KSI is Earth’s newest space research and teaching school dedicated to the advancement of human civilization through exploration and development of extraterrestrial space ([www.keplerspaceinstitute.info](http://www.keplerspaceinstitute.info)). With appreciation to Dr. John M. Wilkes for his editing.*



A rendering of the lunar base from the architectural schematic.

# FALLING TO EARTH:

## AN APOLLO 15 ASTRONAUT'S JOURNEY TO THE MOON

REVIEW BY MIKE WHITE

Everyone makes mistakes, though some are more public than others. In Colonel Al Worden's new memoir "Falling to Earth," he finally opens up about his mistake regarding the Apollo 15 postal cover scandal that cost him his job at NASA.

Worden's memoir starts, just as Worden did, on a farm in Michigan, which assists in the reader's understanding of his upbringing. Worden also inserts some humor into this part of the book, which otherwise would have been fairly dry.

From there, Worden takes readers through the stages of his life that led to his job at NASA, emphasizing his time at West Point and his time as a military aviator. He tells stories of mascot thievery during his time as a West Point cadet and a military aviation instructor so tough that few had the stamina to complete his course.

Then, of course, Worden tells readers about his time with NASA. He discusses the circumstances surrounding his divorce, and his fear that it would affect his future with NASA. He also talks about the meetings that lead to the now infamous postal covers and everyone's role in the scandal.

According to Worden, the scandal occurred when he and the other Apollo 15 crew members accepted payments in exchange for signing and flying with postal covers that would then be sold years later. However, the other party did not hold to their part of the agreement and sold the postal covers much too early.

Worden was one of only 24 men to travel to the Moon, and like the others he was hailed as a hero upon his return—receiving invitations to take part in celebrations and parades, and commendations from politicians at a local and national level—until the word of the sale of "Apollo 15-flown postal covers" reached his NASA employers. At that point, all the revelries of a hero, as well as any hope of a future with NASA, disappeared. Little did Worden and the Apollo 15 crew know at the time, the NASA employers had just dealt with similar issues from a past mission, and were looking to make an example out of Apollo 15.

Worden is very open about his past and all of the mistakes he made, and even admits to regretting some of those past events. He also discusses how his feelings changed toward his fellow crew members, as well as his NASA employers, throughout the events that followed the mission.

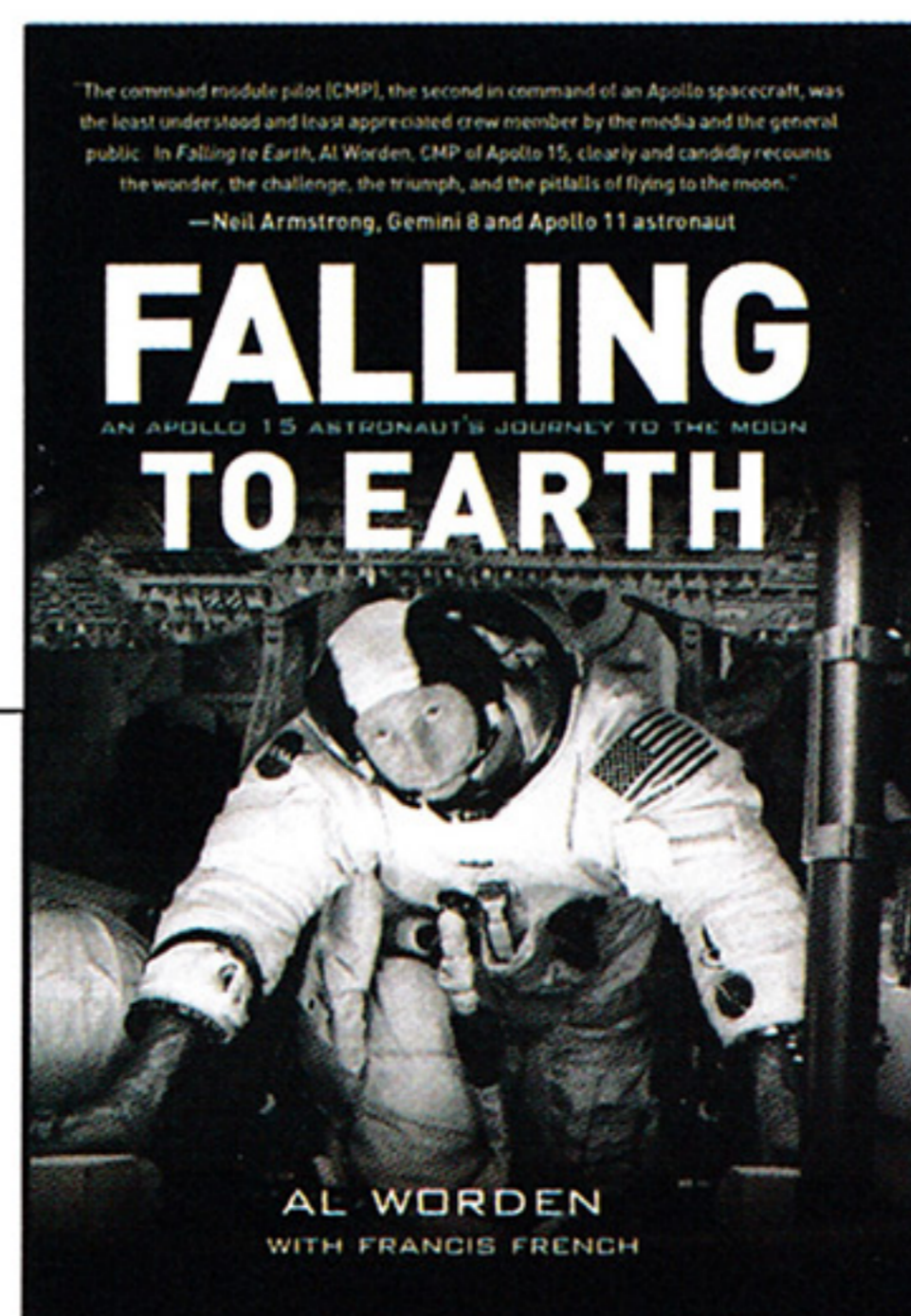
"Falling to Earth" is the latest in a long line of astronaut memoirs, and, like the others, it does not disappoint. It is written chronologically, starting with his youth in Michigan and concluding in the present day.

Overall, the book is cleverly written, right down to the double meaning of the title. "Falling to Earth" should be read by any space/NASA enthusiast, especially those who want to know the truth about the postal cover scandal or more about Al Worden and his Apollo 15 crewmembers.

*Mike White is a freelance journalist based out of a suburb of Chicago, Ill.*

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<b>Title:</b>	Falling to Earth
<b>Authors:</b>	Al Worden, Francis French, Tom Stafford, Dick Gordon
<b>Format:</b>	Hardback
<b>Pages:</b>	312
<b>Publisher:</b>	Smithsonian Books
<b>Date:</b>	2011
<b>Retail Price:</b>	\$19.77
<b>ISBN:</b>	978-1588343093

# THE SPACE SHUTTLE:

## CELEBRATING THIRTY YEARS OF NASA'S FIRST SPACE PLANE

REVIEW BY ARIEL I. RAYMAN

The space shuttle program has come to an end, and as author Piers Bizony puts it, "this book is a visual celebration of a flawed yet brilliant spaceship whose kind we may never see again in our lifetimes."

Bizony's work in the science, aerospace, and cosmology community is unprecedented and "The Space Shuttle: Celebrating Thirty Years of NASA's First Space Plane" is indicative of his love and knowledge of space. This retrospective look at the space shuttle program encapsulates Bizony's passion for the industry. The full-sized coffee table book is a magnificent journey through NASA's fleet of orbiters, depicting how the shuttle was developed and designed, and demonstrating how each mission evolved over time through trial and error.

Though the surviving winged orbiters are being decommissioned and retired to various museums across the nation, their legacy will be preserved through Bizony's work. With more than 900 stunning images, Bizony visually celebrates the space shuttle program's history with brief descriptions of each space shuttle mission. From the successful inaugural launch of STS-1 to the lessons learned from the tragedies of STS-51-L and STS-107, this book historically documents every one of NASA's 135 space shuttle flights.

In chronological order, Bizony regales the reader with space shuttle mission history from inception to final flight. From STS-1 to STS-135, Bizony provides the reader with details, albeit brief, of each mission to include the launch date, landing date, crew, mission milestones, and magnificent images captured during each flight. Bizony does not provide exhaustive accounts of each mission, but provides basic details that would satisfy most space shuttle enthusiasts. And what this book lacks in technical detail, it more than makes up with visual stimulation.

However, one major criticism that must be addressed is Bizony published this book before the space shuttle program's final flight. Bizony would have successfully accomplished his mission of releasing a comprehensive book of the entire space shuttle program had he waited to document STS-135. Though he provides a brief mission milestone, he does not include what was actually accomplished or when the flight launched and landed. Most importantly, the reader is left without any mission photographs. It would have been a fitting end to a fantastic book if Bizony captured Atlantis touching ground in the early morning of July 21, 2011 for the final time at Kennedy Space Center on Runway 15.

In a nutshell, "The Space Shuttle: Celebrating Thirty Years of NASA's First Space Plane" is suitable for the casual space fan who wants a fabulous collection of space shuttle mission images. The brief mission factoids and the failure to include the final mission only offer readers a superficial glance at the space shuttle program's mission history, but this book would serve well as a quick reference or a platform for autograph seekers who can easily have astronauts sign their names next to each corresponding mission.

For a space shuttle enthusiast who craves for technical detail of the space shuttle program from development to final flight, there are certainly more suitable books to fill that need. However, if you want a 300-page photo album of stunning photographs of the space shuttle and mission images, this book is a must-have addition to your space shuttle library.

*Ariel I. Rayman, a former member of the NSS Board of Directors, is an attorney and freelance writer practicing in Washington D.C.*



**Title:** The Space Shuttle: Celebrating Thirty Years of NASA's First Space Plane  
**Author:** Piers Bizony  
**Format:** Hardcover  
**Pages:** 300  
**Publisher:** Zenith Press  
**Date:** 2011  
**Retail Price:** \$24.95  
**ISBN:** 978-0760339411

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### Region 6 Chapters Organizer

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## START OR JOIN A CHAPTER!

If you support the exploration and development of space and the creation of a spacefaring civilization, joining the National Space Society (NSS) is a good first step.

## BUT WHAT IF YOU WANT TO DO MORE?

If you want to meet others of like mind, if you want to explore how your special interests and abilities fit into the larger picture, if you want to share your enthusiasm, if you want to engage in research or teach others about space, then you should join an NSS chapter. It's easy!

Your first step is to see if there is a chapter that meets your needs already. Chapter listings and contacts are in every issue of *Ad Astra*; or check the chapter listings online at <http://chapters.nss.org/a/lists>, then contact the local leaders or check chapter web sites for upcoming events and activities near you.

There are special-interest chapters, focused on topics such as space, medicine, or space elevators. Local chapters

also often concentrate in special areas—rocketry, space education, or original peer-reviewed research on space settlement, for example—and will generally welcome distant members who share their particular interests.

If there are no existing chapters that meet your needs, it only takes a little preparation and perseverance to form a new chapter. Contact the vice-president for chapters to indicate your interest. When sending an email, type "NSS New Chapter" in the subject line and include your name, address, and contact information (email, home/mobile phone). A Chapter Starter Kit, containing the basic how-to-get-started guidelines, will be sent out to you.

Once your new NSS Chapter becomes official, you can start by meeting in a house, restaurant, or check for free meeting rooms at local libraries, museums, banks, etc. Chapters aren't for everybody and we understand that. But you do have friends out there you haven't met yet, and once you get together there's no telling how far you can go.



## UNITED STATES CHAPTER LOCATIONS

**OH** Cuyahoga Valley Space Society  
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Parma, OH 44134-1252  
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**WI** Lunar Reclamation Society, Inc.  
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Contact: Peter Kokh  
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Phone: 414-342-0705  
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**WI** Sheboygan Space Society  
728 Center Street, Kiel, WI 53042  
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### U.S. REGION 7 CHAPTERS:

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Newcastle Space Frontier Society  
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**Emphasis:** Canadian Space Activities

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Phone: 1-888-MARS-4-US  
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Web: www.MarsHome.org  
**Emphasis:** Mars Settlement projects

NSS Chapters Assembly  
942 E. Tilghman Street  
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Contact: Dennis Pearson  
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Phone: 610-434-1229  
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**Emphasis:** NSS Chapter Support

Students for the Exploration and Development of Space (SEDS-USA)  
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Phone: 203-610-3378  
Web: www.seds.org  
**Emphasis:** Student-based space advocacy

The Moon Society  
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**Emphasis:** Lunar Exploration and Settlement

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Web: www.angelfire.com/space/usis  
**Emphasis:** Space Governance

## SPECIAL INTEREST CHAPTERS

### Space Nursing Society

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Palmdale, CA, 93551  
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Phone: 661-949-6780  
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Web: www.spacenursingsociety.net/  
**Interest:** Space Nursing

### Suffolk Challengers for Space

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**Interest:** International Space Business



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### **A 'Rose' Made of Galaxies**

In celebration of the 21st anniversary of the Hubble Space Telescope's deployment in April 2011, astronomers at the Space Telescope Science Institute pointed Hubble's eye to an especially photogenic group of interacting galaxies called Arp 273.

The larger of the spiral galaxies, known as UGC 1810, has a disk that is tidally distorted into a rose-like shape by the gravitational tidal pull of the companion galaxy below it, known as UGC 1813. A swath of blue jewels across the top is the combined light from clusters of intensely bright and hot young blue stars. These massive stars glow fiercely in ultraviolet light.

The smaller, nearly edge-on companion shows distinct signs of intense star formation at its nucleus, perhaps triggered by the encounter with the companion galaxy.



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